worm eaten so thoroughly that its top was merely the projections between the worm holes. These were somewhat irregular and some of them penetrate nearly the full depth of the layer.

#

Extreme edgewise make up the limestone layers in shaly unit above the Maurice.

Most Cambrian features are shown in this section.

Notes on Meagher — etc

Beartooth Butte.

The Wolsey consists of the usual micaceous & sandy shale sediments. Abruptly it changes to the limestone, which while impure and thin-bedded stands up as cliffs wherever the slope is steep enough to keep it free of Talus.

The basal layer, about 3 to 4 inches thick, is very dense but yielded a good fauna. The lower layers of this formation are separated by shale bands up to several inches thick. Above these few basal feet the shale disappears and the rock becomes more nearly a pure limestone. No fossils were observed above the basal layer. Sandy shale surfaces fucoidal.

Most of the layers consist of a peculiar intraformational conglomerate composed of thin laminae that look on the weathered edges like thick brachiopod shells. One layer observed was composed of Girvanella up to an inch long but averaging about a half inch.

A 2½ inch layer of rather pure light colored Vaughanite was

Algonkian ~~Rocks~~ Formations of Central Montana —
Chas D. Walcott

Introduction

In 1898 I ~~studied the~~ made a reconnaissance of the pre-Cambrian ~~rocks~~ formations of the Belt Mts of Montana & published the results on their section (Proc. Geol. Soc. America. Vol 10, pp. 201-215. 235-239.

extended from the Cambrian above to Archean complex ~~[illegible]~~ at the base. In 1900 I crossed the Belt Mts & endeavored to trace the connection, north of Helena, of the Belt terrane & the pre-Cambrian rocks of the Rocky mountain "front" at the Lewis & Clarke pass & north on the south fork of the Dearborn river. It was evident that a great series of strata extended westward beneath the Cambrian, that was in general similar to the Belt terrane but quite different in detail.

In 1901 at my request Mr. Bailey Willis studied the Front ranges of the Rocky mountains in northern Montana ~~& adj~~ and found a great series of strata referred to the Algonkian#

#Bull. Geol. Soc. America, vol. XIII, pp. 314-324.

In the Survey of the Coeur d'Alene Mining District of Idaho Dr. Waldemar Lindgren & F L Ransome an FC Calkins found ~~a ta~~ much of the region underlain by stratified siliceous rocks referred to the Algonkian.[3]

[3] Folio No. , U.S. Geol. Survey.

During the field season of 1905 I again had the opportunity of studying the pre-Cambrian rocks of Montana & of measuring the section from N.W. of Scapegoat mountain on the Continental divide westward across the Swan & Mission ranges to the valley of Flathead lake.

In this paper I wish to ~~correlate~~ compare the various sections thus far studied & to correlate them as far as practicable.

4.

The ~~Scapegoat~~ Campcreek, ~~Sugar~~ Mission range section will be taken as thee type section owing to its being of greater vertical range & embracing portions of the northern section of Mr. Willis & the western section of ~~the~~ Lindgren.

Scapegoat, Mission, ~~Sun~~ Mission range section.

The Upper portion of Scapegoat mountain is formed of ~~a~~ great mass of Carboniferous & Cambrian limestone superjacent to silicious Algonkian ~~rock~~ strata forming the ~~base & ridges of~~ main ridge of the "Continental ~~Divide~~ & the spurs descending from it (5) on the north, west, south & southeast. On the East & northeast the limestones slope towards the Dearborn river drainage (1).

---

(1) On the south fork of the Dearborn river, the section of the limestones is as follows

Add section of 1900

After a reconnaissance of the entire area I decided to measure the Algonkian section at localities where each of its units, or formations were best exposed.

For the first ~~an~~ upper series ^ ~~the~~ (over) sharp ridges on ~~S~~outh east + north-west side of Camp Creek were selected. Camp creek heads close to the Continental Divide ~~+ flows~~ northwest of Trap mountain and flows south-~~north~~west to where it enters Danahers creek four miles above the head of the south fork of the Flathead river. (See topographic map of Ovando quadrangle, montana).

Algonkian.

Belt ~~Series~~ terrane

Camp creek formation.

At the summit the fine conglomerate at the base of the Flathead sandstone of the Middle Cambrian rests, with apparent conformability on the Algonkian strata. The layers of both formations dipping north at an angle of 70°. ~~The~~

Camp creek series.

Da

Compact, hard, grey sandstones, almost quartzitic in many layers. Layers vary in thickness from 1/4 in to 10 in. Often marked

by mudcracks & ripples.
Towards the top the
dip is about 70° north,
500 feet in thickness
below the dip increases
to 80° & then decreases
to 75° near the base.

1762 ft.

From this point the section
was measured on the
east side of Camp Creek

2.a Reddish brown
arenaceous shales & thin
bedded sandstones, alter-
nating irregularly with
greenish grey bands of
shales & sandstones, some
of the thicker layers 2 to
6 in are almost quartzitic

1560

2.b Greenish sandy
shales with thin
layers of greenish

grey compact sandstone at irregular intervals 612

2c. Reddish brown ~~sandy~~ shaly sand-stones. 51

2d Reddish brown thin bedded sandstones, becoming more massive ~~&~~ compact and almost quartzitic 50 to 75 feet down. About 50 feet from the base, the layers are more or less cross bedded coarser grained reddish-grey in color & from 2 to 14 in in thickness 970.

3.
Reddish brown sand-stones that 285 feet from the top gradually pass into ~~shaly~~ alternating thin bedded reddish

10

reddish sandy coloured, shales & sandstones. Toward the base there is 60 feet of reddish & green sandy shales. 1362.

Stet 4.a ~~Reddish brown thin-bedded & shaly sandstone~~ → 76

b. Greyish-red sandstone in layers 8 in to 2 ft thick alternating with shaly sandstone bands and partings. 510

c. Reddish brown sandstones & shaly beds. 910.

Ripple markings and mud cracks occur abundantly in upper part.

5. ~~Hard~~ thin bedded ~~darkish~~ grey sandstones & shales, almost quartzitic in the thicker

In back

5) alternating thin bedded grey, hard sandstones & sandy shales alternating with an occasional quartzitic sandstone layer 8" to 12" thick.

~~[illegible]~~, 11 at 360
feet down light
grey sandy shales, ~~a~~
slightly calcareous
in places have a
thickness of about 30
feet. Below the
sandstone layers are
thicker ~~&~~, with less
shaly beds. and almost
quartzitic in ~~the~~
~~thicker~~ layers. 700.
at 175 feet from the
top a reddish brown
~~belt~~ 15 feet thick occurs,
otherwise this great
grey sandstone band
and a similar band
below ( ) are
conspicuous features
in the ridges as the
grey color ~~st~~ is in
strong contrast with
~~the~~ rich, reddish brown
bands

Ripple marks & mud cracks are of frequent occurrence.

6)

Compact, impure, grey, limestone, siliceous, arenaceous, thin bedded & shaly, weathering buff to yellow on many of its layers. 198

7a Grey sandstones in layers 2 to 8" thick with alternating bands & parting of shaly sandstones. 482.

7b Reddish brown thin bedded & shaly sandstones. ~~F~~ . 68
Sixteen feet from the top a layers ~~of~~ ~~Cryptozoons~~

about 75 ft thick is nearly made up of irregularly semi-spherical masses of Cryptozoan. The latter are calcareous, in an impure sandstone matrix.

7c Grey, shaly & thin bedded compact sandstone 425.

A bed of Cryptozoan occurs 325 ft below the summit, in a rough grey sandstone layer about 4 feet thick.

7d Reddish brown sandstones. thin bedded and often shaly 753

7e Grey, thin bedded and shaly sandstones

with mud cracks &
ripple marks. ~~on~~ 158

7f - Reddish brown thin-
bedded & flatter shaly sand-
stones. 623.

7g: Grey thin bedded &
shaly sandstones with
mud cracks, wave &
ripple markings. 85.

~~7h~~ 8, chocolate red, thin
bedded sandstones
alternating with
impure, grey arenaceous
limestone layers. 395.
Cryptozoon is
abundant in small
forms in a layers
six inches thick 25
feet from the top. ~~of~~
~~this~~
Resume.

15,

1. Grey sandstones -	1762.	1762
2,a Reddish sandstone	1560	
2b. Greenish sandstone & shales -	612,	
2c Reddish brownish sds	51.	
2d " " sds	970.	3193
3. Reddish brown sds	1362	1362
4. Reddish sds	1496	1496
5. Grey sds	700	700
6. Siliceous limestone	198	198
7a Grey sds	482-	
b Reddish sds	68-	
c Grey "	425	
d Reddish "	753	
e Grey "	158	
f Reddish "	623	
g. Grey "	85	
h Reddish "	395	2989
		11,700

Holland ~~limestone~~ formation (Carr.)

The red beds of the Camp creek series rest conformably on the limestones of the Holland formation. about a mile above ~~the~~ the mouth of Camp creek ~~and~~. The contact between the two formations can be traced for many miles to the north, south and southeast. at Camp creek the Holland formation is broken by a fault in the canyon valley of Danaher creek, but to the south, a little north of south of Scapegoat mountain the entire section of the limestone is shown in fine

Type locality - Holland peak, Swan range. where the entire section is exposed.

exposures in the canyon of the north fork of Blackfoot river below Dry fork. The section was measured on the ~~eastern~~ high ridge east of ~~the~~ river and passes ~~through~~ over Mineral hill.

Above this Holland limestones the red & grey ~~sand~~ arenaceous series of the Camp creek series extend northward to the Cambrian of Soohegrab mountain.

~~II~~ 1) Passage beds.

~~Int.~~ gravel sandy layers, pinkish to dull red with coarser grains of sand than below followed by grayish buff weathering, slightly calcareous, fine grained sandstones. The upper half has more more buff & yellowish beds & the lower half more of the reddish beds. 155.

2.

Shaly limestone, alternating with thin layers of grey limestone, near the top a few oölitic layers occur, & throughout an occasional layers with Cryptozoon. About 730 feet down the shaly beds give way to bedded grey limestone alternating with impure, dark grey & buff weathering limestone. About 160 feet from the base the shaly limestone again predominates with ~~[illegible]~~ frequent layers of oolitic & siliceous limestone. Cryptozoan is abundant in the lower 100 feet ~~especially about the summit of Burnell mountain~~ 1310.

3. Calcareous shales with bands of greenish arenaceous shale 155.

4. Thin bedded and shaly grey limestone with occasional layers of grey limestone 2 to 10 in thick. In the lower 70 feet, oolitic layers and semi cherty layers occur. The siliceous portions of the latter weather buff & the irregular nodules and stringers of grey limestone a bluish grey. Cryptozoan occurs abundantly

in the upper 60 feet on
the high point N.N.E.
of Mineral hill ~~mountain~~;
Fine specimen of
Cryptozoon two feet +
more in diameter occur
in a beds 3 feet thick
at a horizon 360 + 373
feet below the top.
815.

5. Thin bedded, more or
less shaly compact
grey limestone weathering
buff + grey. 520.

6a. Grey limestone in layers
8 to 20 in thick, with irregular nodules + stringers of
cherty matter weathering
buff. extends down
about 330 feet where
there is a gradual
change into banded
calcareous + siliceous beds.
with layers of grey

limestone. These gives way 1040 feet down to grey-compact, siliceous, buff weathering limestone, in shaly bands & thin layers. Siliceous matter becomes more ~~frequent~~ prominent until the only evidence of calcareous matter is ~~the~~ buff weathering beds, 28 feet thick. A bed of pinkish colored siliceous rock in hand, compact smooth layers occurs 285 feet above the base. Cryptozoan of large size 1ft or more in diameter occur, 165 feet from the top. 1850.

Summary.

1. Calcareo-arenaceous beds 155,
2. Shaly limestones 1310.
3 Calcareo-arenaceous sh 155-

4. Thin-bedded lim, 815,
5. Shaly & " " " 520.
6. Silicious limestone, 1850

4805

In this section, below the Holland limestone the purple & green siliceous beds of the Ravalli series have a thickness of 2150 feet up to a fault 2.5 miles south of Mineral hill.

The Holland limestone series with ~~the~~ siliceous red beds above & purple beds below are repeated to the westward of the Continental divide in the Swan & Mission ranges. The limestones forming the high summits on both ranges. West of the Mission range the

younger (23) portion of the
~~limestone~~ ~~Lake again~~
~~partially brought~~ to
Holland limestone series
is exposed in the high
hills east of Ravalli
and Jocko creek.
Before the limestones
there ~~are un~~ is a
great thickness of siliceous
beds, the lowest beds
of which were found
near Ravalli.

Ravalli series.

1.
Fine grained, ~~siliceous~~
quartzitic sandstones of
purplish-grey & grey
color. In the lower
portion the purple &
purplish grey form bands
of color & above the
grey & then the purplish
~~tints~~ predominate

2550.

2) Bedded, compact, grey sandstones. 1060

3. Greenish grey, fine grained, compact quartzitic sandstones in layers 4 in to 2 feet ~~thick~~ with an occasional bed of shaly sandstone. 4645.

Resume New page

1.	Purple & grey beds	2550
2	Grey — "	1060
3.	Greenish grey "	4645
		8255

The base of the section is on Jacko creek about a mile above Ravalli.

25

New p 9

Resumé -

Cambrian =
Unconformity:

Camp creek series		11710.
Halland	"	4805.
Ravalli	"	8255.
Total thickness		24770

Lower Little Birch
Creek section -

7-24-14

Newland fm

Lower fossil bed top

1) Bedded lim - layer
3-5" thick 13- 74-0

2) Shaly lim 10-2ft 59,0

3. Blue gray thin
✓ bedded lim, 2-1ft 212.6"

4, ditto weathering
✓ buff brown - 4 22-6"

5, Calcareous shale
✓ in thin lamellae
when weathered, 86. 487-0

655-0

✓6,
Fossil bed - No. 13
✓ Shaly lim & some
beds of oil - shale, 31 3165 -

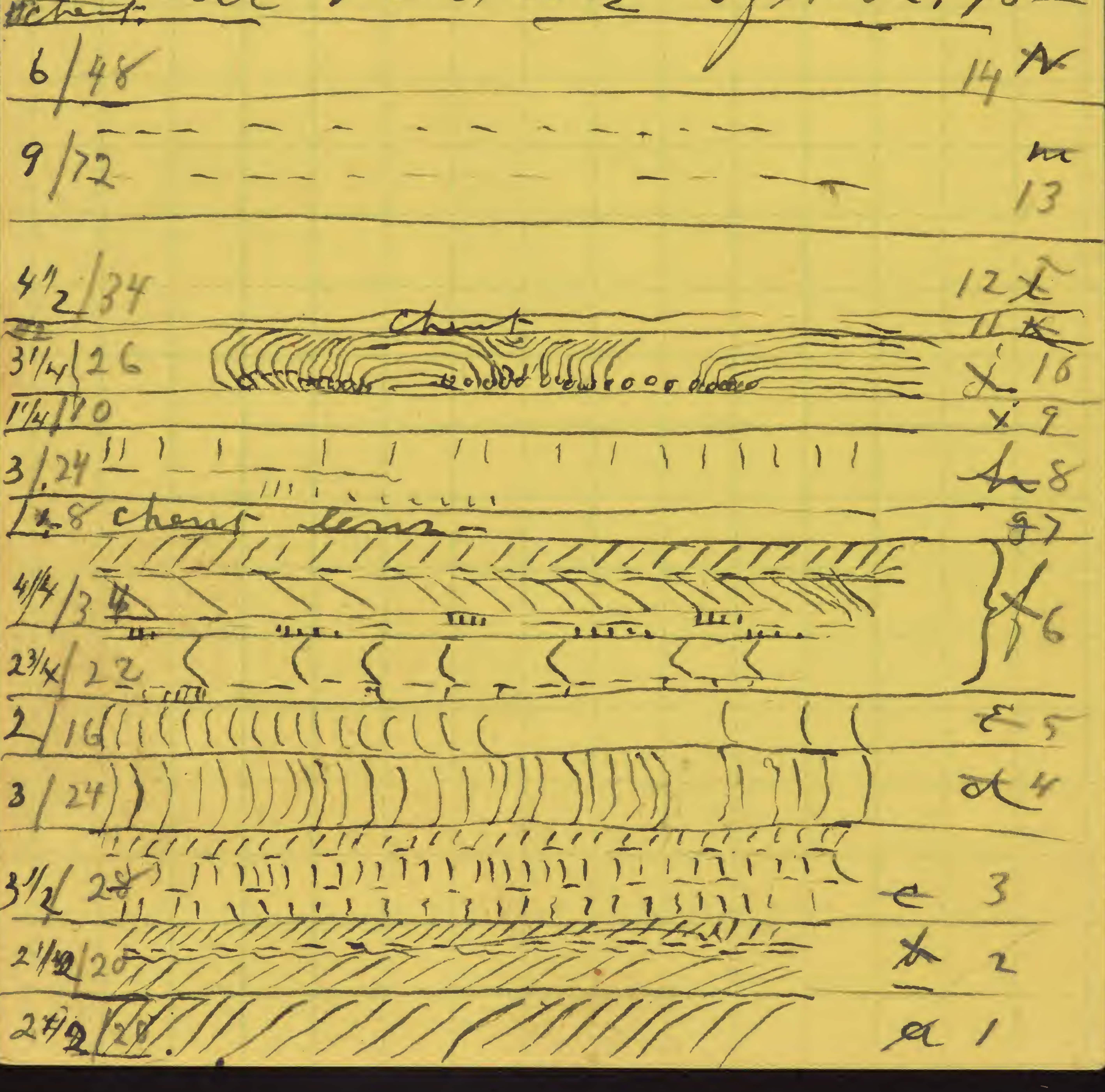
~~7. Eruptive~~ -

July 21/14 { Algal flora

See drawing by Mr. V. W.

Section as exposed in face of low cliff - on south side of south Branch of Birch creek 9 mi W. of White Sulphur Springs. Montana.

Total thickness of bed. 48 in



47

3 1/2

8-23-14

Newland formation.

Section. Ridge road.
Going up.

1) algal lim. with algal beds at several horizons. 60 ft
St N+S, dip 30 E.

2). Calcareous sh. passing quickly to arenaceous sh. 345

3) algal lim. 35

4). Arenaceous shaly beds 590

5) algal lim. 57-
St, N+S, dip 30 E.

6) ar. sh. with a few layers of lim. scattered in it 310

129

600.

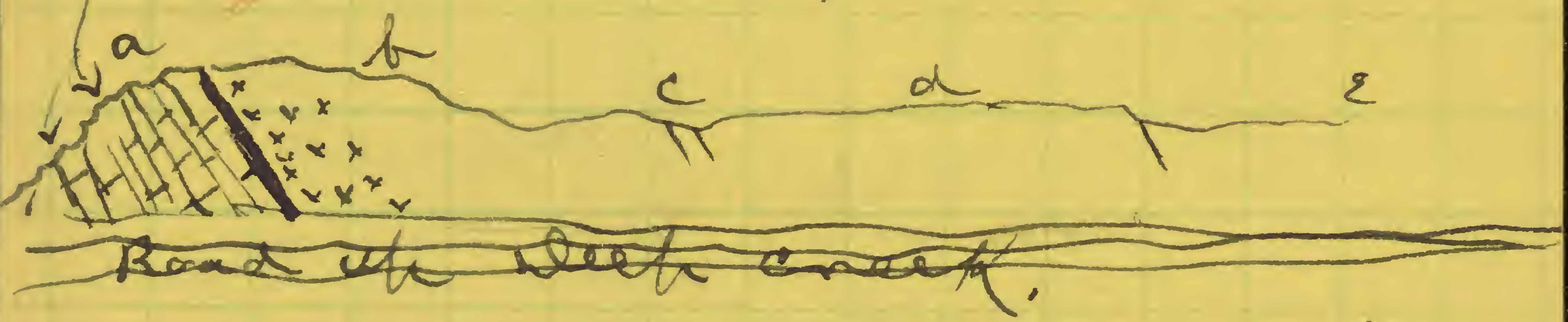
29
120

8-23-14

7) Bluish-gray lm	30
8) ar sh -	135
9) Bluish gray lm	20
10) ar sh,	180.
11) massive bedded qtz rd,	60.
12) algal lm -	24.

⑥ | Camaria etc

~~Deep~~ Creek - [Aug. 4/14.
Castle
Newlandia major Zone.
(Locality 400°)



Section exposed on north side of ~~upper end of Deep~~ lower part of Castle Creek on North side of road about a mile above Jap. (Deep Creek).

a) Dark siliceous shaly ~~sh~~ rock - (

b) Interbedded eruptive = (d)

c) Dark blue-gray lime. (Same as E) fault

d) Interbedded eruptive / 42°

E) Dark blue-grey lime (Newlandia major, " frondosa. 12 feet

Dip 60° E. St. N. 25° E. (Mag.)

2) 8-4-14.

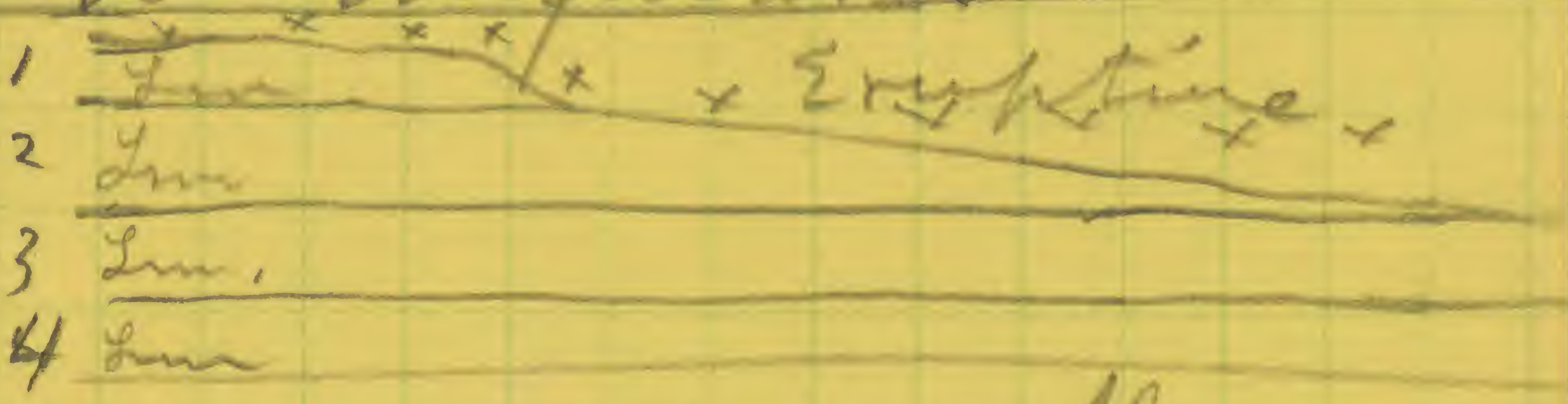
The only relation between the Newlandia limestone & the eruptive rock is that caused by the flow of the eruptive over the limestone. The eruptive must have been relatively cool as it did not alter the limestone at the contact between the two. Another exposure a little way further up the creek shows no alteration of the limestone at or near the contact.

See 6½ × 8½ - photos of Newlandia bed.

3) 8-4-14.

E. Newlandia bed.

at the contact with eruptive the upper surface of the lim- is irregular.



The eruptive flowed over the irregular bottom of the lake, & in placed gather up & rolled into the eruptive fragments of the consolidated ~~the~~ calcareous sediment.

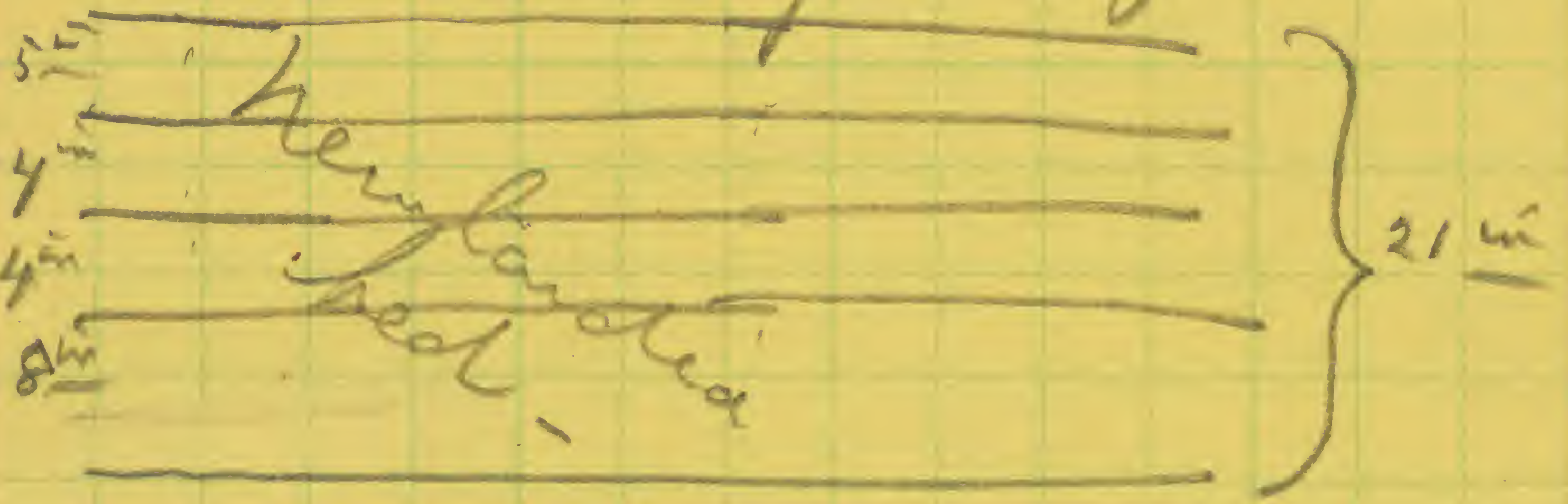
In layers 1 & 2 (above), the coarsely cellular form of alga is well developed.

In 3, a very fine vertical form (or cone-in-cone structure)

4)

(8-7-14)

At 57 ft below the contact *Newlandia major* & *frondosa* are very abundant thru 4 layers of lime



The layers above & below have traces of broken fragments of what may have been of algal origin.

July 25/14.

Newlandia bed.
Birch Creek.

Best exposure found is (south side) on Birch creek – 11 mi west White Sulphur Spgs.

The matrix is a dark blue-gray limestone that rests on an even bedded gray arenaceous lm.
(Locality 400M)

---

a) 10-b { Camasia abundant at top. Large coarsely laminated Newlandia – Camasia.

b 11-b feet. { Thin bedded lm with Newlandia at various horizons – An 8 in layer ~~about~~ 4 feet from the top is filled with it.

1 ft c { 1/2 inch layer Newlandia frondosa – in great abundance

3 ft d { Lower 3 feet with irregular traces of algal deposits. N. gen. [illegible] tubular form.

Arenaceous lm

The Newlandia bed is followed by arenaceous lim- capped by hard brown sandstone

Traces of *Weedia tuberosa* and

occurs in the upper two feet of the bed.

This Newlandia bed appears to be at about ~~the~~ same horizon as the lower fossil bed on South fork of Birch creek - as it has nearly the same strattigrafic relation to the upper bed & has 3 species in common -

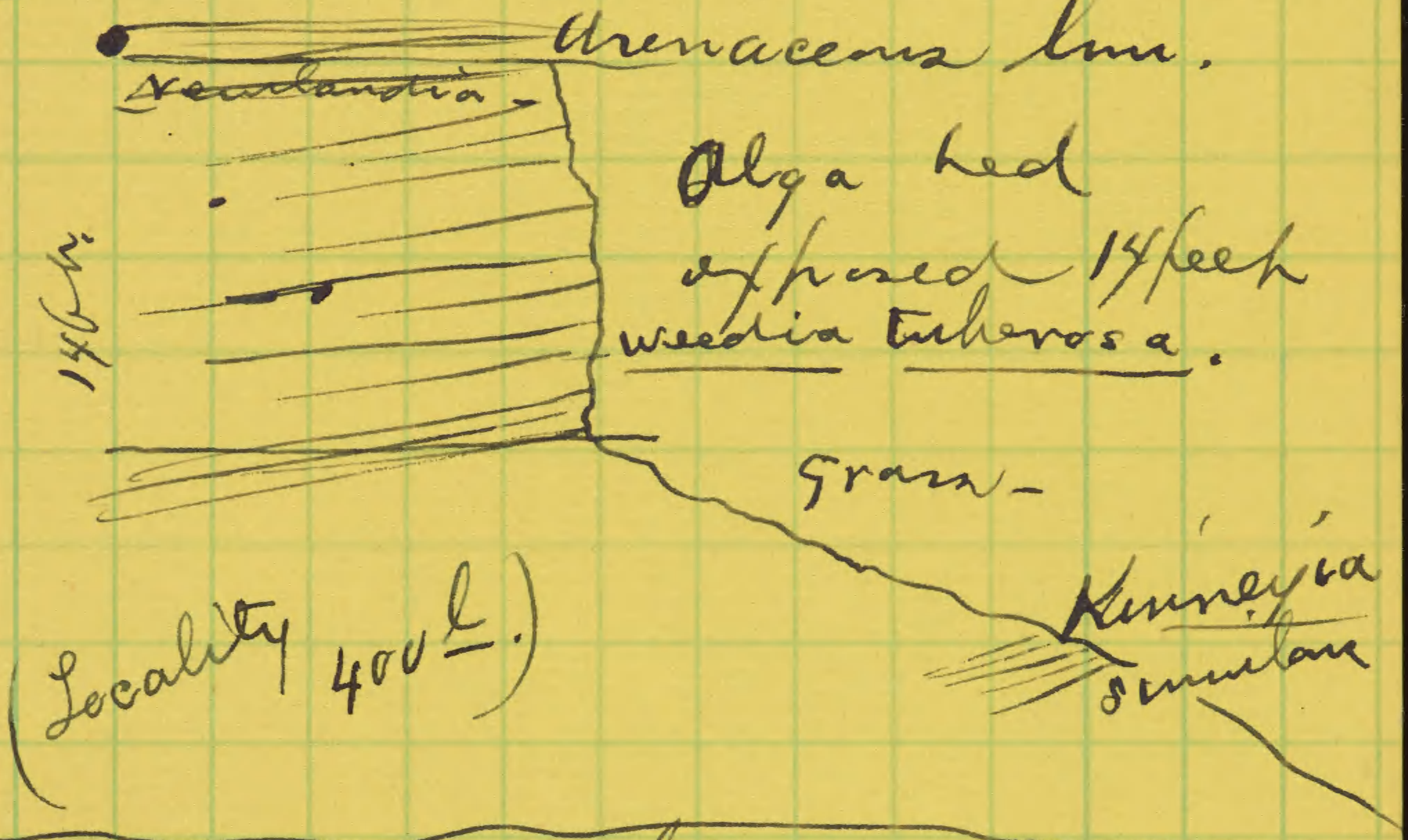
Camasia, *Weedia* & big tubes.

7-25-14

A lower Newlandia bed with large forms occurring about 300 feet below the big bed to the west on bank of Birch creek.

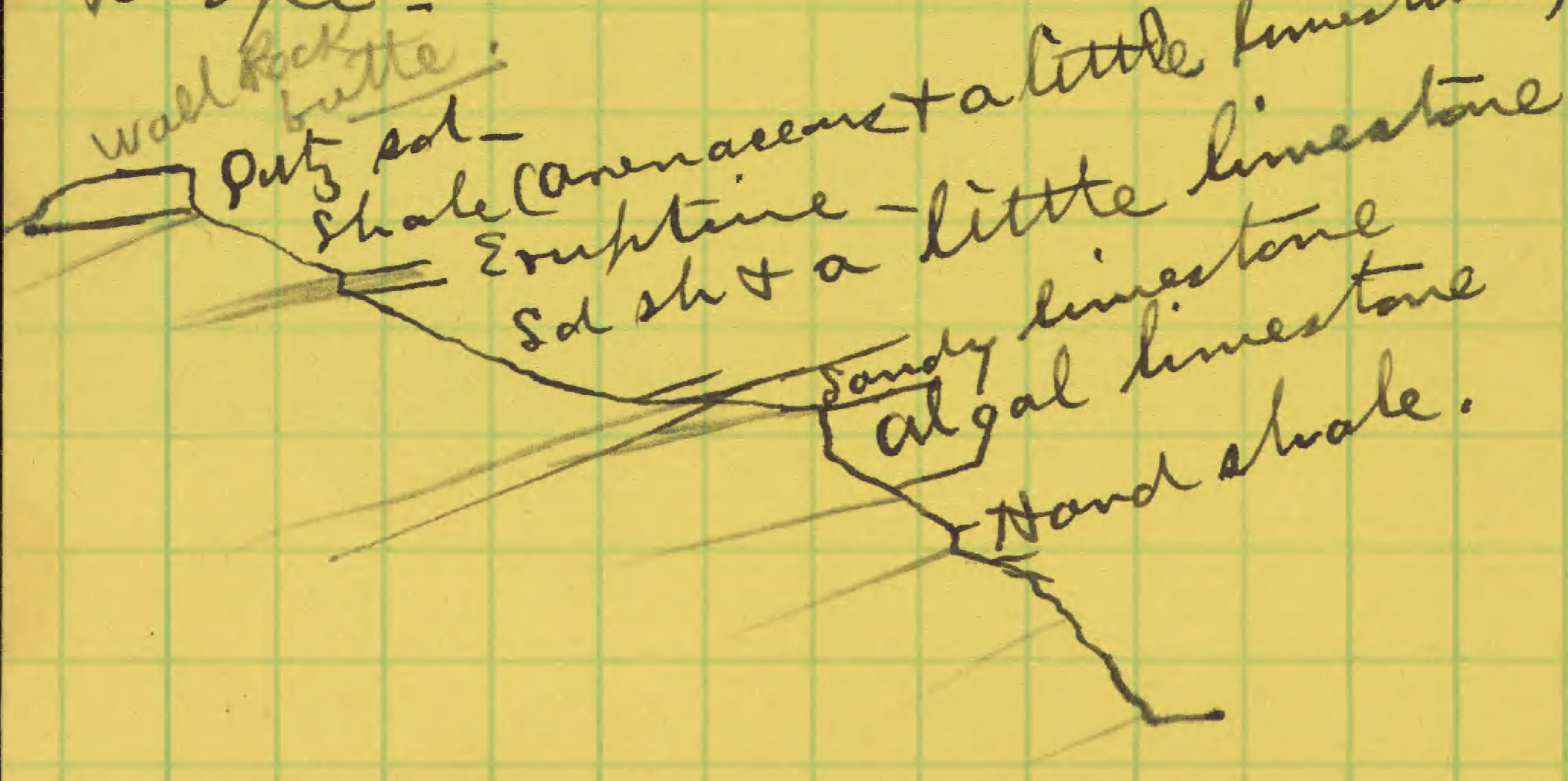
7-22-14

Algal bed.
Upper Birch Creek
(S. side S. Fork).



(Locality 400l.)

The alga bed is from 25-30 feet thick judging from the debris on the slope.

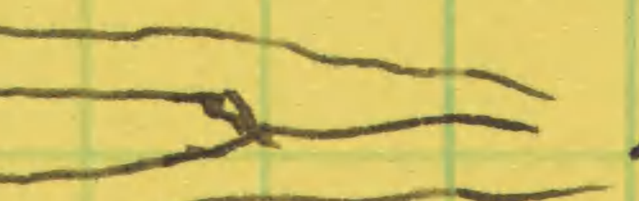

Wall Rock butte:
Qtz sd -
Shale (arenaceous + a little limestone)
Eruptive - little limestone
Sd sh + a little limestone
Sandy limestone
algal limestone
Hard shale.

7-22-14.

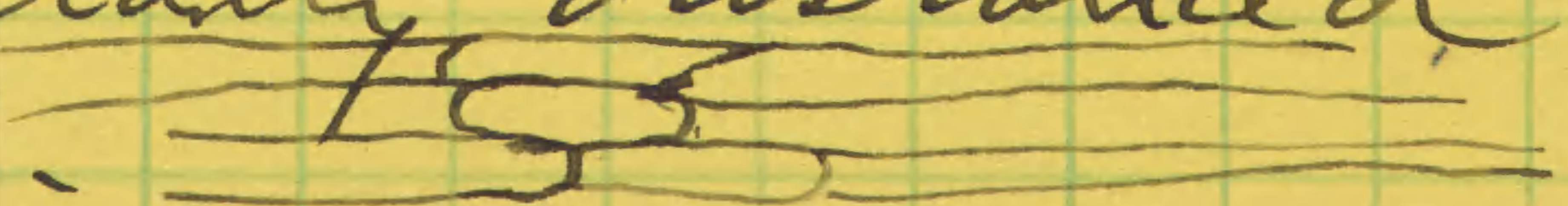
Weedia tuberosa - Newlandea

Where Newlandia becomes closely septate it passes into Copperia ~~Weedia~~ Greysonia. This is finely shown by many natural sections in the low cliffs - of ~~upper~~ Birch creek (South branch)

The even laminations will run parallel to the bedding for (4) four feet or more & then abruptly curve upward, or pass into ~~Weedia~~ Copperia by the appearance of septa about as far apart as the laminations. Sometimes the laminations terminate by union



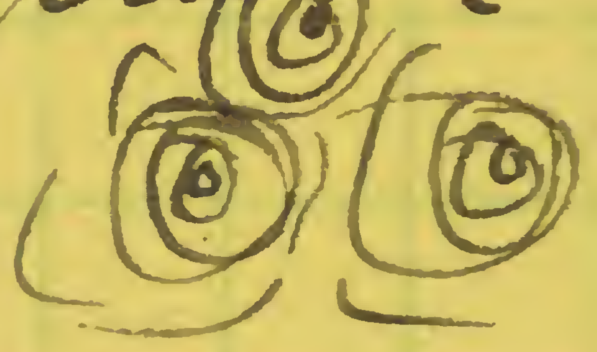
. Again they are cut off by irregularly distanced septa.



7-22-14

Newlandia frondosa

attains its greatest growth at & near the top of the algal bed, along with N. concentrica. The latter is evidently the center of growth of frond-like ~~growths~~ forms that extend for three feet or more & become confluent with the growth of adjoining centers - At other localities numerous centers occur 12 to 15 in apart.



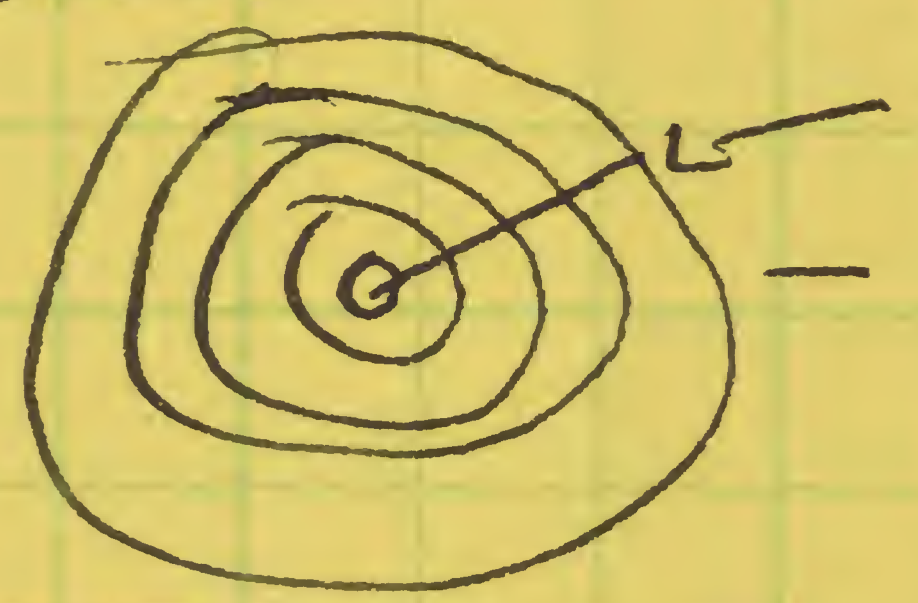
Some of the largest growths at the top surface show laminations 1/2 to 1 in distant from each other

Aug 5th / 14.

N-gen

Greysonia ? ~~basaltica~~ ??

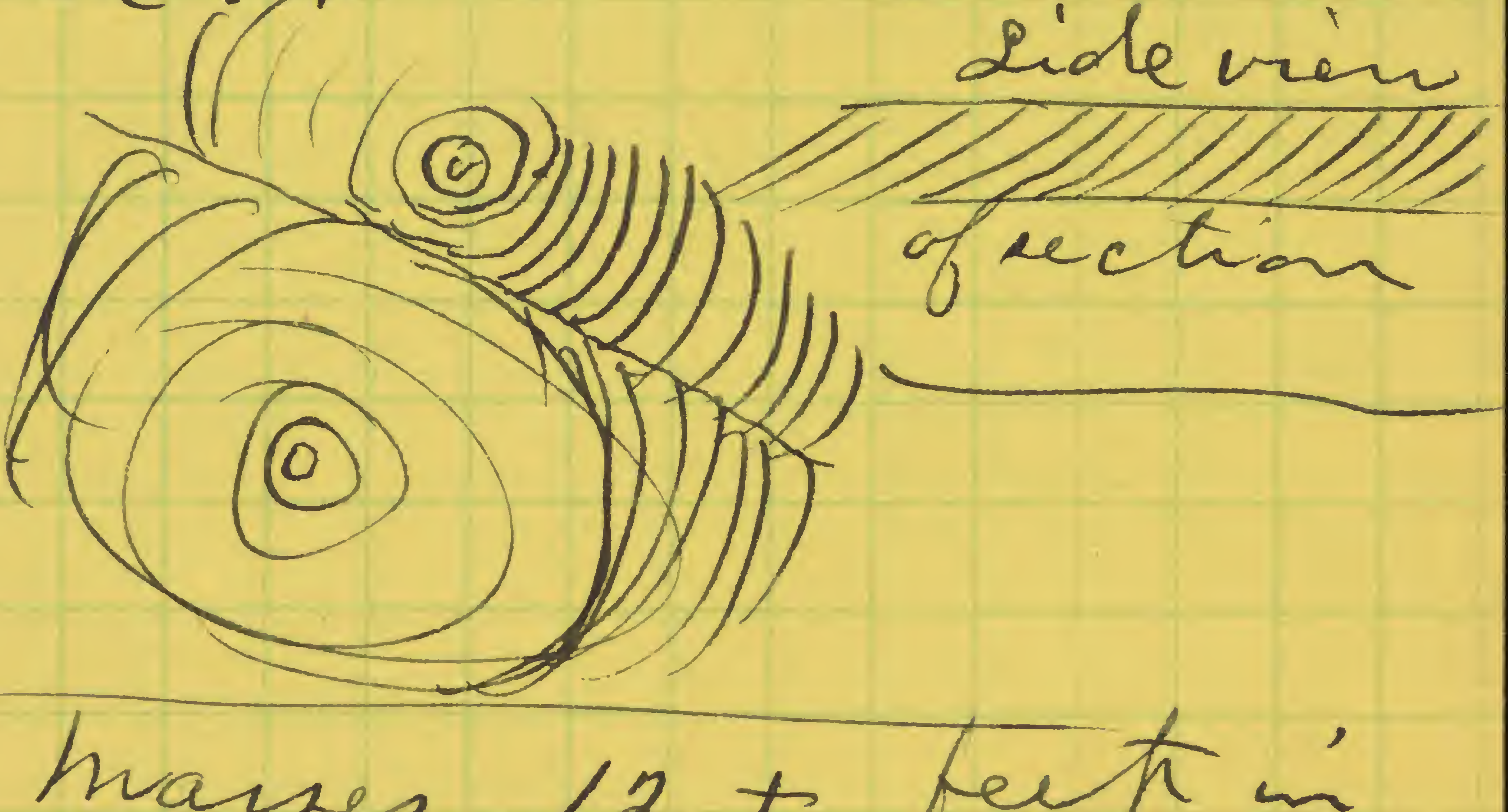
Top view



Locality
400.M.

S.W. branch ~~fr~~ Russell Fork, about 2 mi from Deep Creek, (Small rivulet) ?

Limestone outcrop on ridge on N. E. side of rivulet. Loc. 400 N

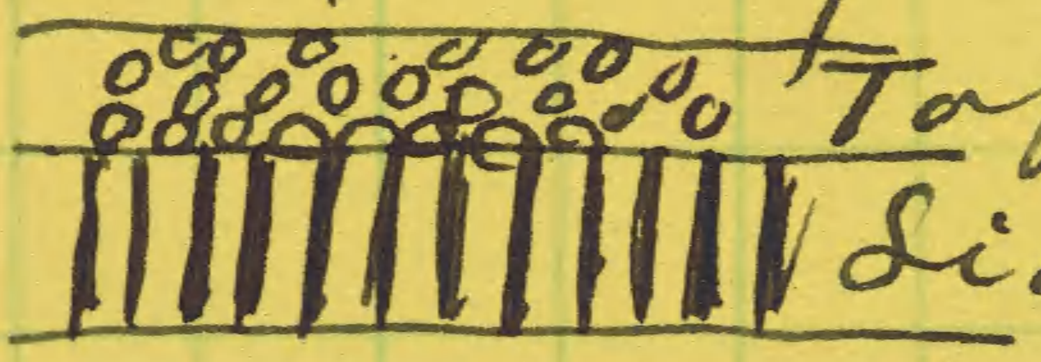


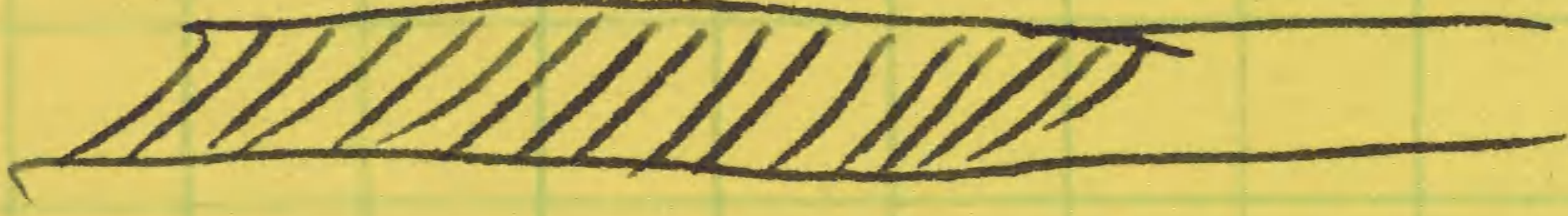
Side view of section

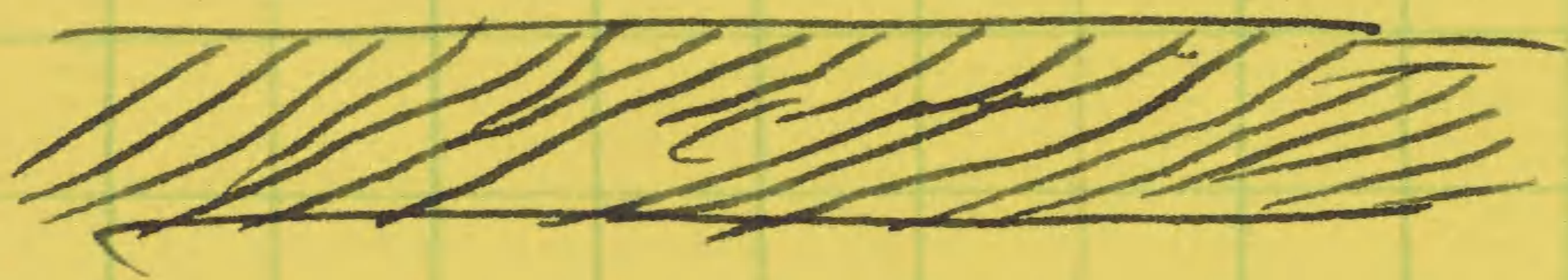
Masses 12 + feet in diameter.

Aug 5/14

Collected a lot of
this form - It is
not Greysonia basaltica
but may be Capperia







7-22-14.

Kinneyia lamellosa -

Field occurrence.

Occurs in thin layers 1/2 to 2" thick interbedded with layers of Newlandia frondosa. Traced it along a cliff face for 1/2 mile. ~~the~~ layers thinning out, + coming ~~in~~. (3 layers noticed) Camasia sp. - occurs in association with it -

Kinneyia simulans occurs in thin layers about 25 feet below - K. lamellosa.

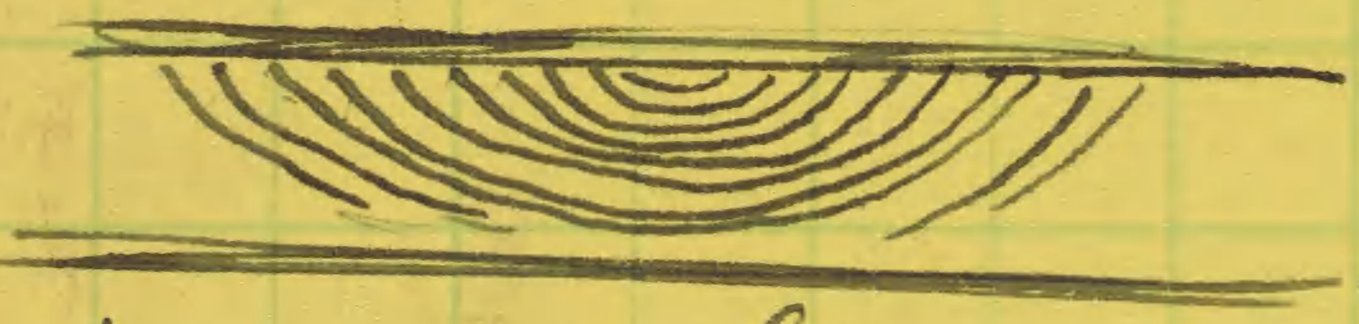
The growth of K. lamellosa is much like that of Newlandia frondosa. only on a much smaller scale.

Locality 400K

7-23-14.

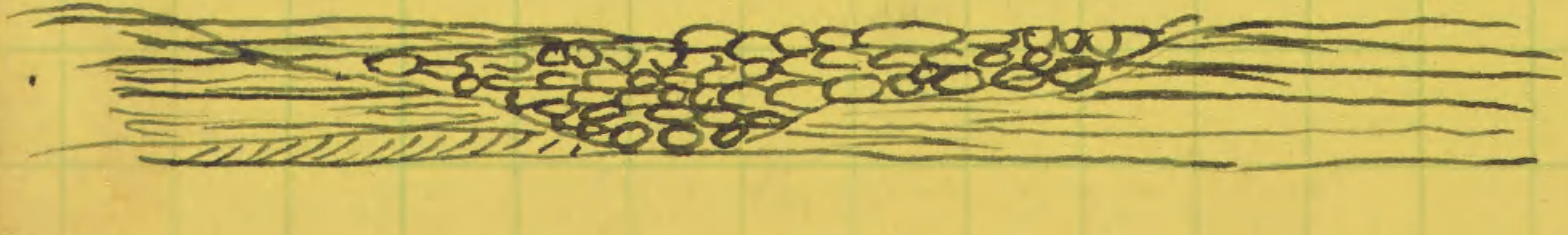
~~Collenia~~

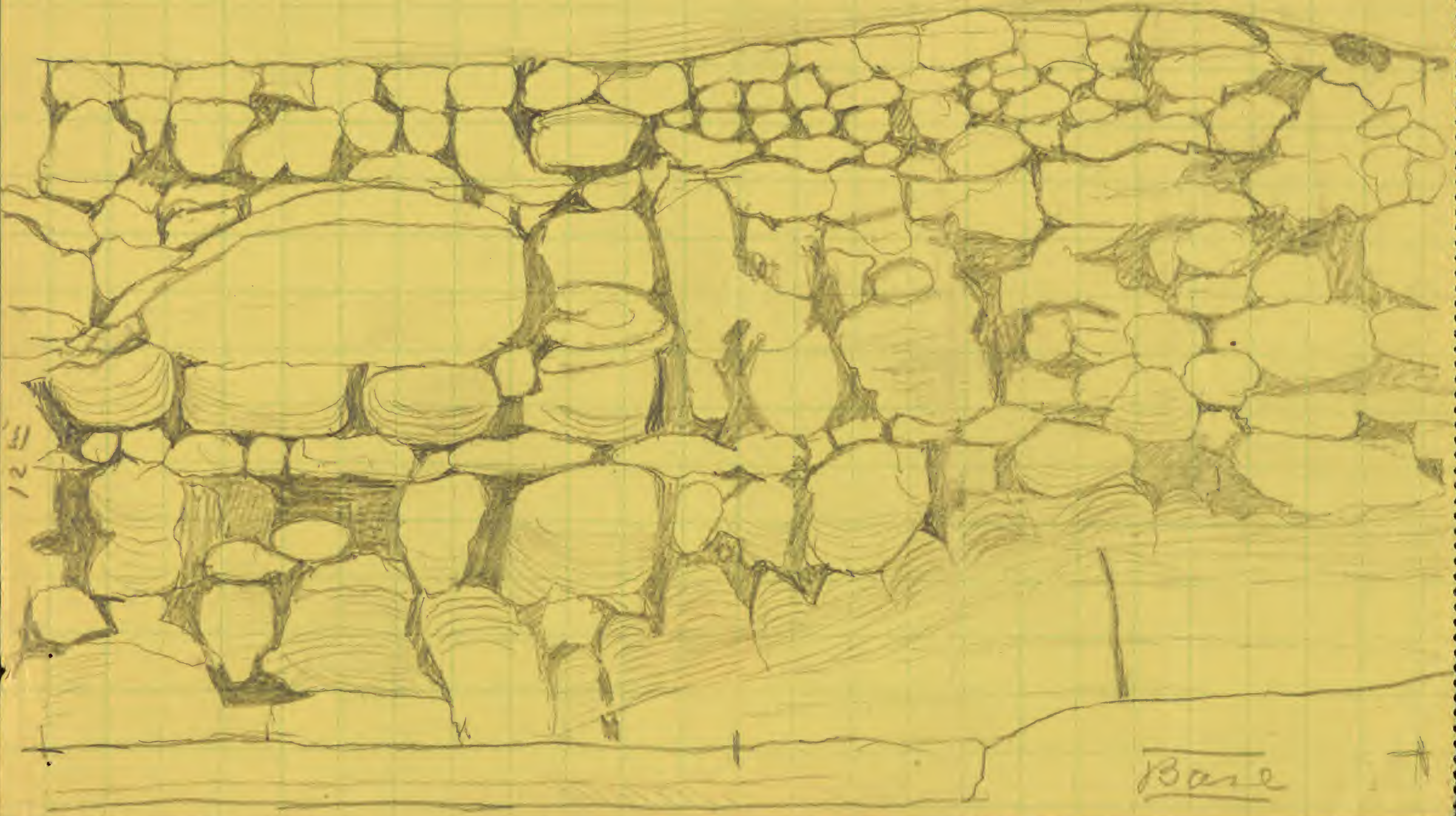
Cryptozoan sp.



Laminae about 5 to ½ in

Occurs in great abundance making up a bed 72 in ~~ft~~ thick broken into numerous layers. The bottom layer 12-14 in thick where sketched is made up ~~of~~ almost entirely of round, oval & flattened ~~ox~~ compressed round & oval ~~forms~~ bodies varying in size from ½ in to 6 in in diameter. These bodies rest in places at the extreme ~~had~~ base of the layer as tho the growth had

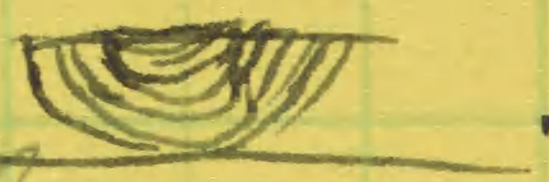




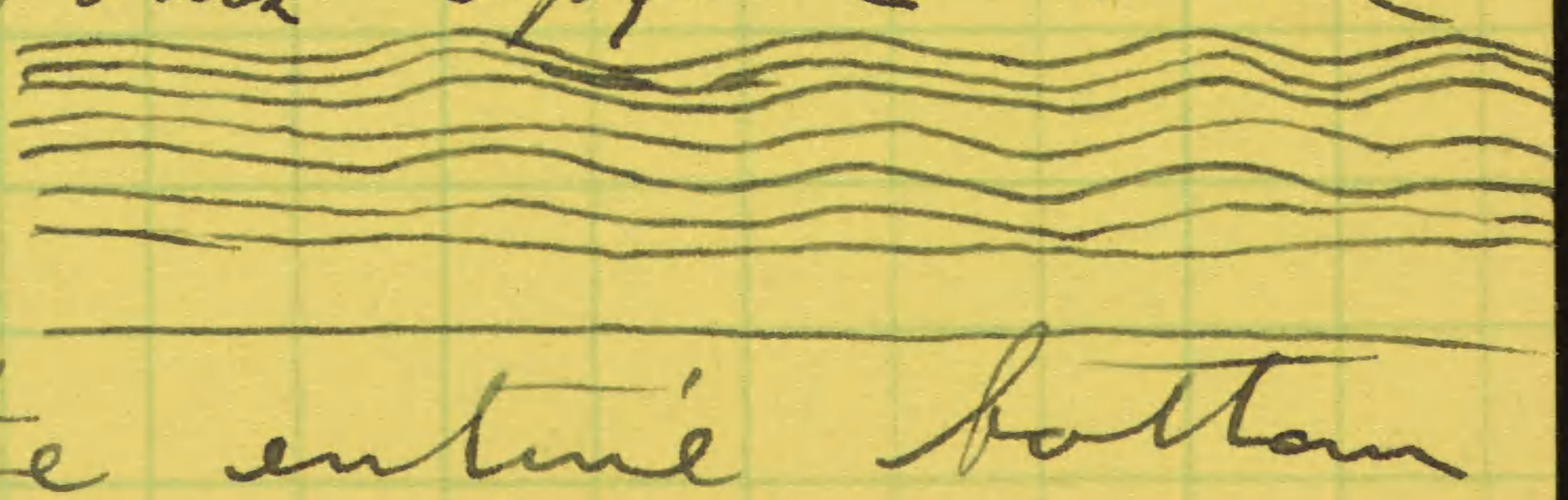
24in
Top.
12 ft
Base

started in spots & spread as the spaces between were filled in by the calcareous mud

Near the top of the 12 in layer there is a band 3 in thick made up of small rounded bodies 3/4 to 1-1/2 in in diameter.

The bodies of this layer rarely show any traces of structure. a few on the weather face of the section show fine lamellas with the edges upward .

In ~~the~~ a finely laminated layer near the base of the 12 in layer. the lamellas sometimes curve upward so as to give a nodular effect. This appears to be where the entire bottom



was covered with an expanded growth.

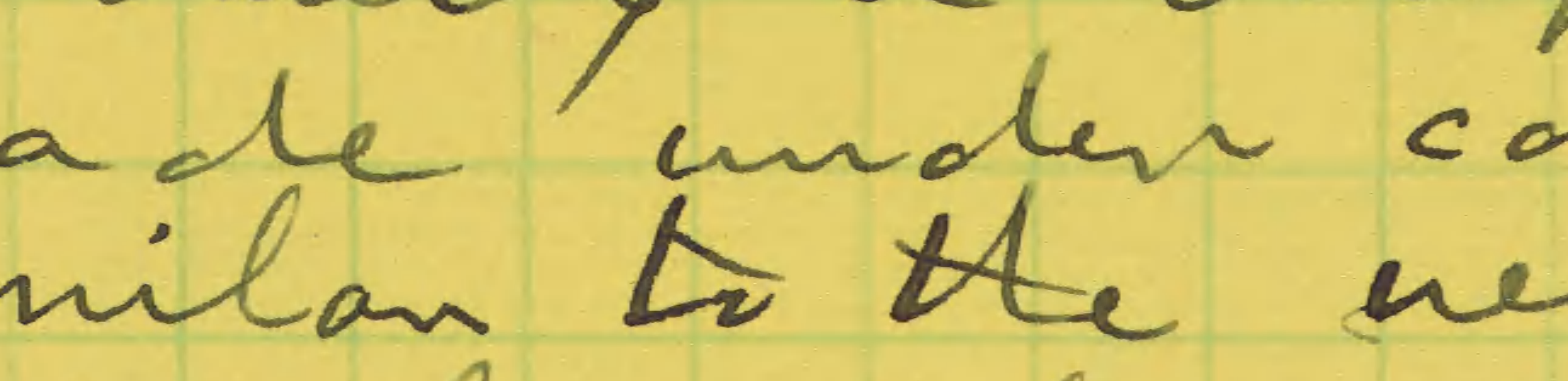
The nodular bodies of the layers above are much like the lake balls of the fresh water lakes -

(A deposite of the lake balls should be found for comparison.)

The layers above the 12in nodular layer are formed of flattened more or less circular laminated bodies with a varying amount of calcareous matrix. These bodies vary greatly in diameter & thickness. The largest noted was 18in in diameter by 1½in thick - The average size is 6in - 10in -

three feet from the base. the bodies are smaller in diameter 2-4" & thicker (deeper) 3" to 5"

at 72" from the base the large nodular structure disappears and a laminated massive bed begins. The laminations are from 3/8 to 1/2" thick & broken ~~up~~ in continuity by more or less vertical partitions. This

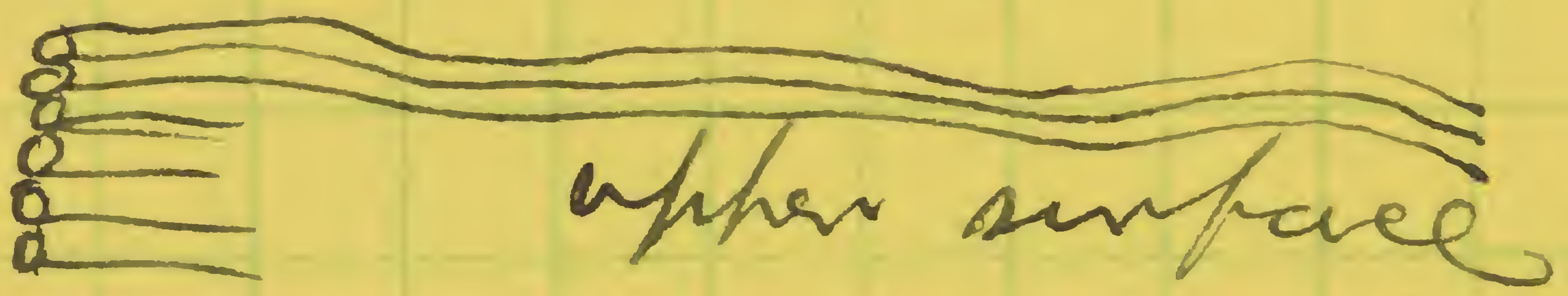


evidently a deposite made under conditions similar to the very finely laminated layers where Weedia tuberosa occurs. at 84" up this type of structure

7-

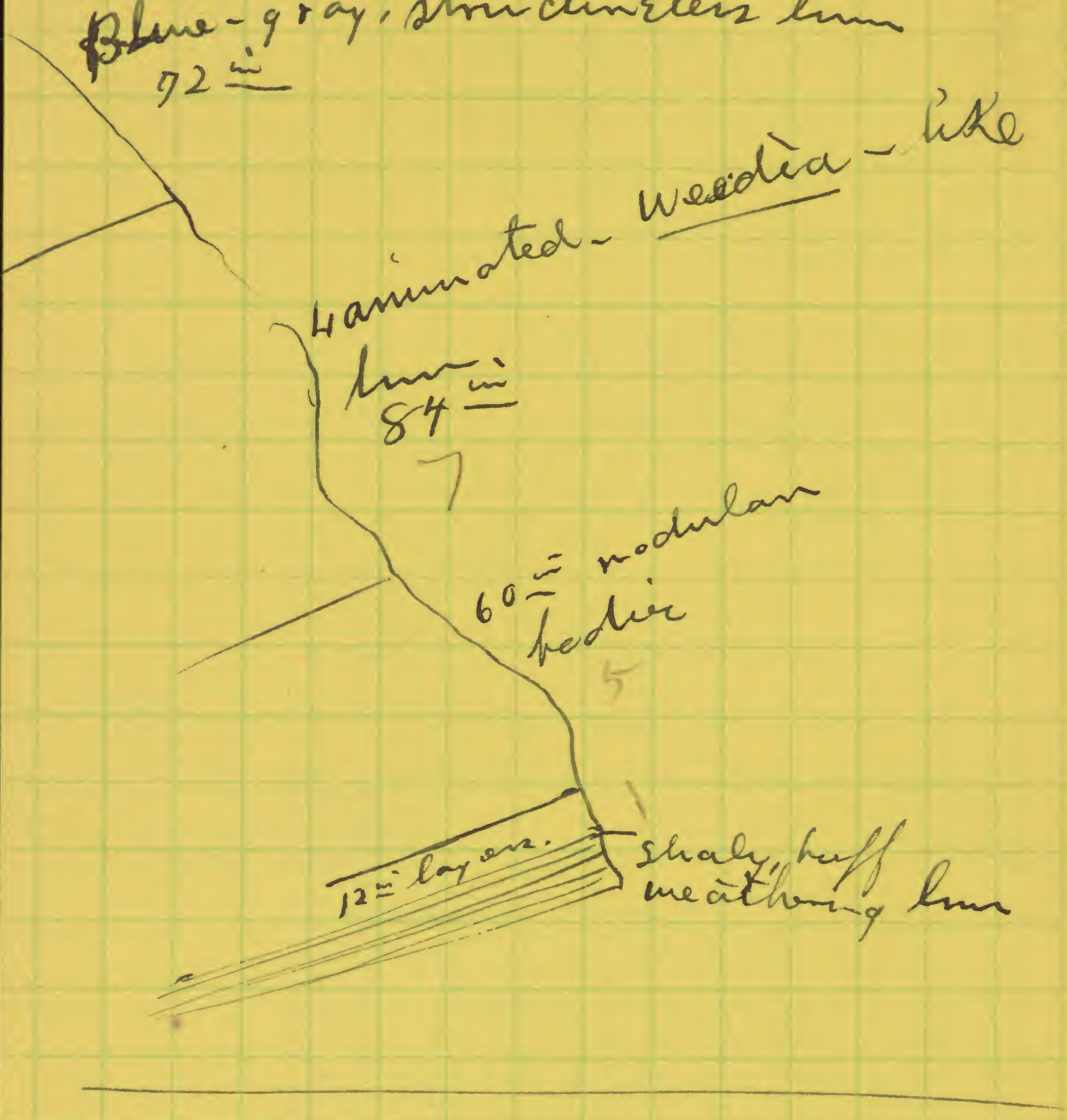
10

ends. The thin laminated layers split apart & give the tubular structure of Weedia tubarosa where the partitions



are numerous.

Above this horizon the oval & round bodies are tracable in the finely laminated & thin bedded bluish gray limestone. This structure is tracable up through 36 in & then thin bedded dark bluish-gray structureless limestone in layers 1 to 4 in thick continue up for 6 feet to thin friable shales with interbedded layers of limestone similar to that below.


Blue-gray, structureless lime
72 in
Laminated - Weedia - like
lime
84 in
7
60 in nodular
bodies
5
1
12 in layers.
Shaly, buff
weathering lime

~~86~~
430
57
487.

688
57. 6

2-612.

86
430.

10:
1:
1:

13
65
8.6
73,6

104

80
7

50.
2
7
59

248

20.

~~31~~
155
20
175.

Aug. 29/14.

Greyson formation -

Dry Creek Canyon.

The upper beds of the Newland formation are exposed on this high ridge to the north of the head of Dry Creek - above the quartzitic sandstones of the Collen formation & then to the southwest the shales & sandstone of the Greyson - Toward the upper part qts sds in layers from 1 in to two feet thick form a high cliff on the south side of the canyon about two miles below Thompsons Ranch.

The Spokane formation

comes in on top of the Greyson about 3.5 miles down & passes beneath the Cambrian Flathead sandstone.

The Flathead sandstone dips S.W. 60°-70° & is finally overturned a mile below the little falls in ~~the~~ Dry Creek.

34.   80.

1

Newland Limestone

Deep Creek section on south side of main mass of the Belt Mts – beginning at a point in the canyon 7½ mi directly south of the summit of Mt. Edith just above old halfway stage station. A rather sharp anticline crosses ~~the~~ Deep Creek canyon on a nearly north & south axis.

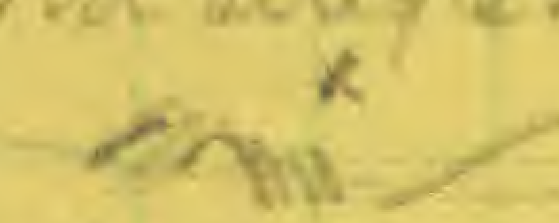
The lowest beds exposed are ~~shaly~~, siliceous, magnesian ~~shaly limestone~~ shaly & thin bedded limestones that dip 60° east. Strike N. 20. E.

1a

Aug. 14/14.

~~[illegible] and lime formation~~

Old stage station



dip 50° S W.
St. N

dip 60° E.
St. N. 20° E

Desh. area

---

1) Shaly + thin bedded lime, siliceous, weathering buff + evidently somewhat magnesian. Frequent exposures occur all along terrace beside inner creek gorge.

Dip decreases to 30° W. 260 ft up in section, where there is a fine exposure at the road crossing the stream.

At 4375 ft up fine exposure of banded arenaceous layers on south side of road + stream dip 60° W.

4375

68
340
45

20, / 63
315
4

5

19

58
290
39

330

2.

2/ ~~dirty~~ dark, dirty gray fine grained compact sandstone becoming shaly in the upper 15-6 feet, 385

3.) Dark bluish-gray limestone in ~~thin~~ layers 2 to 10" thick. A band of algal lm. 6 ft. thick occurs 8 feet from the bottom ~~22~~ 22

4002

4) Dark ~~lt~~ siliceous shale — 355

5) Dark bluish-gray lm. in layers 2 - 10" thick — Partings of shale occurring at varying /

2
64

320
40
360

24
120
15
13

53
265
17
282

3

thickness: at 330 feet of traces of Collenia (400 S) occur in layer 8 in thick - 360

6) Dark & gray siliceous & sandy sh, / 135

7) Blue gray lm with band of algal lm at 56' frm the base 4 ft thick (400 S) / 19 ft

8) Shale, arenaceous & calcareous in bands with three narrow bands of impure

drab lime weathering buff.

282

9. Dark ~~Bluish~~-gray lime with algal bed (400 ft.) 12 feet thick. 7 feet from base—

47.

10.) See p. 5—

(Aug. 14/14.

5

~~Aeroland formation~~ -

Beginning at fossil bed below
rangar ~~Station~~.

10) Shaly lm. with a few layers
of lm. (Bluish gray).
Dip 75°. St. N. 20° W. 115.

11) Calcareous & arenaceous
shale passing into, ~~a~~
thin bedded dirty
brown rd & then
into shaly lm at
660 ft. 730

12) Bedded bluish-gray
lm in layers &
4005 shaly beds.
Noted obscure Calenia
20 feet ab. 105,
dip 70°-75°

31
155

6

13) Dark siliceous shale with layers of arenaceous thin in lower 12. feet

32.

---

a change in sedimentation + consequent rock occurs. Shows shallow water and turbulent conditions

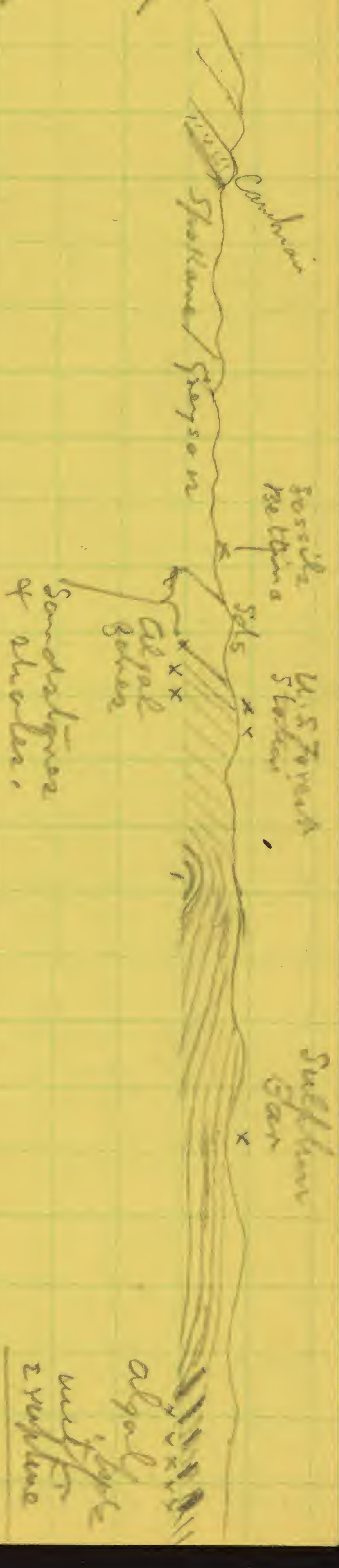
7

Aug. 10/14

Newland Lm -

Deep Creek -

L



21
105

34
170
20
190

Aug. 16/14.

Newland series on
~~at upper~~ Castle creek
above forks of Deep creek
(Algal & eruptive.)

1. Shaly mag. lm of
25 lower beds.
St. N. 20° E.
Dip 45° E. 1200

2. 2 Sandstone 4.

3. 2 similar to (1) 20.

4. 2 Eruptive — 12

5. 2 Sandy sh with
sd. 40

6. 26 Eruptive 125

7. 19 Sd-sh. passing
into siliceous sh 190

389

45 220,

225
30

90

359,
894
343
660
95

2381

aug 16/14.

8. Band of dark
18 bluish-gray ~~tri~~ thin-
bedded lm, 30

9. Eruptive 60,
17

10. Sh — 260
16

11 (15) Eruptive 275

12. Arenaceous +
(14) cal. shale
passing into
cal. sh. 255

13. Banded blue-
17 gray lm. 14
Upper 6 ft.
Newlandia
bed.

90 3^{2} 34

aug 16

14.
12) Emptiness — 50?

15. Concealed + sd
11 sh — 130.

16. Cal sh +
10 thin bedded
ar - lm. 105

17 Blue-gray lm
in layers 1" to 6"
9 St, N+S. 35
Dip 60° E
traces of algal
deformation 23.

43
215

25
125

42
210

Aug 16.

18) Shale cal, with a few thin layers of lm 240

8

7) 19 Eruptive ~~2~~ 28

—

6) 20) Shaly beds Calcareous — 145

5) 21) Dark gray ish blue lms traces of algal deposits — 12

4) 22) Shaly calcareous beds at ~~4~~ 5 ft = layers blue-gray lime 295

97
291
1455
195
1650

232

150
750

250
1250
170
1420

150
30.

40

91

1420
368

Depth

23) Blue-gray lime in layers 3-12in / 35

24) Eruptive 60

2381.

25) Calcareous sh. 170

Colten ~~New~~ formation 2556.

~~26~~) Sand sh. with layers of qtz sd. 854

~~27) Sdy sh~~

Aug. 17/14

Greyson formation

1. Arenaceous and siliceous shales - at 1985ft where a lentile of eruptive occurs.

800 600

155

466. 1

5 500.

65

2330. 565

310 1650

2640. 2215

4500. 3400.

600

3100

Greyson. (2)

at 2215 a thin sill
of eruptive -

at about 2640, a
bed of impure -
arenaceous lm carries
a Collenia-like
algal deposite -

Shale becomes more
arenaceous & with
numerous thin bedded
greenish sds & at
3380 ~~pebble &~~
reddish pebble
sds occur in a thin
band - & at various
horizons above traces
of them occur in the
yellowish-buff sandy
shales which predominate
above - 4000 ft -

at 5100 ft of reddish

Greyson (3)

brown sandy shales came in & dominate.

Total Greyson — 5100 ft.

Spokane formation —

Reddish-purple-orangey shales with thin hard layers of ~~ye~~ light & ~~yell~~ Buff Tinted sandstone —

The mass of Grass mountain is made up of the Greyson shales & sands — & not the Chamberlin as I thot when working East from Mt. Edith.

The Greyson beds go up Castle Creek road, ~~nearly~~ to about 1/4 mi west of the divide.

What becomes of the Newland & Greyson formations in the section from Mt Edith to Black Butte is a problem — Probably not deposited as there is no trace of them until the Newland shows up toward Wallrock Butte

123

372
1860
24

2100

218

656
5

3380
440

3820

Aug 13th/14.

Section of Greyson formation along the south side of Deep Creek beginning just above Glenwood (Guest Ranch house) where the canyon of Deep Creek begins and extending along the hills forming the south side of the broad Deep Creek bottom. The dip of the beds as shown by frequent exposures is from 40° to 60°.

The fine sand appears to have been washed into relatively quiet water & evenly distributed in thin layers — Little trace of mud

1.85

cracks — ripples on
~~cranes~~ bedding +

19

88

230

680. 229
3400 688
45 3440
460

233
756
5

3870
525

7^{5^6}

4395

350

1040

5200
690

5890

xxx) 18 a

Greyson formation.

(Twist in section on N. side Belt Creek swings strike to N. 20° W.

~~The~~ Slightly calcareous shales passes quickly into a siliceous, abundant fossil shale, gray-greenish & dark gray.

At 710 feet the Beltina fossil bed occurs on the south side of Belt Creek in cliff just above Glenwood.

(At 895 the shales become more arenaceous & rougher surface.

895.

xxx. Section starts on N. side of canyon & crosses at the cliffs on west side Ross' Canyon on road.

Grey s gr (19a)
above Glenwood.

Grey shales (siliceous
+ a little calcareous.
St. N 50° W.
Dip. 60° S.W.

Thin layers of dark gray + buff red – occur, occasionally but the great mass of the arenaceous shale is a dull yellow or buff color. The sand was fine grained + weathers down into rounded hills. The high cliff continue all across the section.

at (680) 3850M a little reddish shale is interbedded and 3900 a hard compact red-ish gray predominates. that extends up to >56 4395 ft + then the yellow

175
526
5.
2630
450
3080.

300.

5890
340
3080
9310

2a

rd sh - appears &
continue to (1040)

5890.

c). Light colored qtz sds
& sh - (60) 340

Spokane formation.

1) arenaceous shales &
soft thin bedded sds
with occasional bands
of light-colored ~~soft~~
but very firm sds -
& a few layers of qtz rd. 3080.

Flathead sandstone.

~~17~~
~~95~~
105

43
129
645
85

30
70

660

26

1

Big Belt Mts - Montana Aug. 10/14

Stratigraphic section from the granitic batholite of Mt Edith eastward toward Black Butte. (Line of section E.S.E. (E. 10° 20° S. mag.)

The summit of Mt. Edith is formed of light gray hard, compact, siliceous & aluminous jaspery thin bedded rock passing upward gradually into a fine grained hard sandstone. This mass is over 750 feet thick and slopes to the south east. The section is broken to the north & east of the summit by the granitic batholite the outcrop of which extends northeastward around the north side of the deep cirque

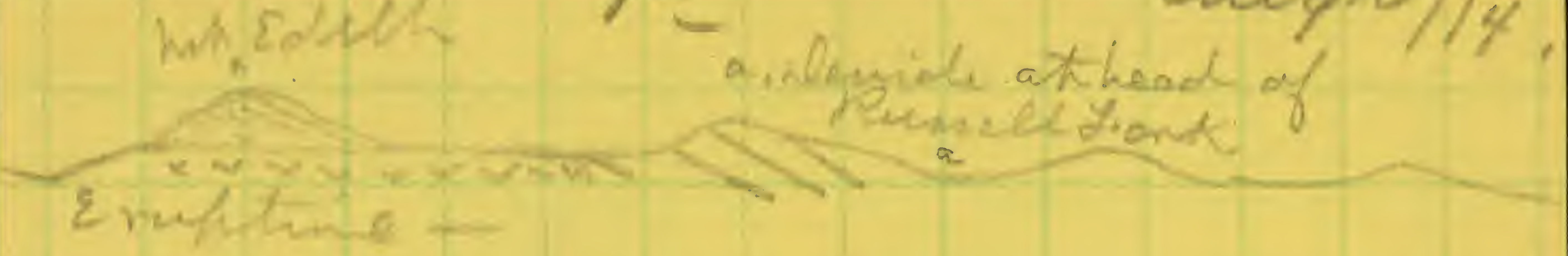
1a

aug. 10/14

on the east slope
of the mountain.
The section begins on
the east & west ridge
connecting Mt. Edith
with the divide at the
head of Russell Fork which
flows south into Deep
Creek. The contact
of the siliceous ~~strata~~
beds of the Algonkian
with the batholite
is about two miles north-
east of the summit of the
mountain where the siliceous
layers strike N. 10°-20° E.
& dip eastward 20°-25°.
The section was measured
by rod & clinometer compass#
beginning with the lowest
beds & going on up.

Refer to method —

1b Aug 10/14.



Algonkian
Beltian -

Chamberlin formation

1. Compact, hard, ~~siliceous~~, light to drab gray, silicious, banded almost jaspery sedimentary rock in thin layers. The beds become more distinctly arenaceous about 300 feet up & gradually pass into a fine grained compact, hard sandstone, 795 ft

2) Sill of eruptive rock similar in appearance to the bathalite 170

3. Siliceous & arenaceous

Aug. 10

layers similar to those of 1. 135.

4. Sill of eruptive rock similar to batholite 160.

5. Dark, hard, silicious shale with thin fine grained arenaceous layers distributed irregularly throughout its thickness 1025.

6. Sill of eruptive rock similar to batholite 395

7. Dark, hard, silicious shale passing into thin bedded silicious rock similar to that of No. 1. of this section. Beds of fine grained, dark silicious shales occur throughout 1235.

3)

~~maroon~~ fine dark sil shales – (~~218~~) ~~[illegible]~~

8. Compact fine grained siliceous ~~rock~~, dark gray rock in layers 2 to 8 in in thickness (~~12~~) 70

9. Fine dark siliceous shale passing into hard arenaceous shaly beds (~~140~~) 795.

10. Compact hard siliceous 2 in to 2 ft thick layers more or less banded. ~~Co~~ Dark grey color predominates but purple & greenish bands of layers occur. (~~58~~) 330 ft

The section follows across the ridge between Russell Fork & Deep Creek

$$\begin{array}{r} 18 \\ 54 \\ \hline 270. \\ 36 \\ \hline 305. \end{array}$$

4) & crosses Deep Creek about 1/2 mi below divide at head of Deep Creek.

Strike on west side Deep Creek N & S – dip. 40°

Aug 11/14.

11) (a) Shales - siliceous gray, greenish, drab. from flat valley of Deep Creek where section crosses & continue on up the ~~hill~~ ridge on the east side of Deep Creek

This series of shales appear to be a formation distinct from the Chamberlain series below

At 305 feet a few layers of ~~305~~

120
360

1800
240

2040

~~3~~ hard sandstone occur.
This is in the stream
bed of Deep Creek.

(b) ~~Other~~ The ~~[illegible]~~ "shales"
pass into sandy
shales and continue
up the slope to
~~the~~ eastward with
dip of 25° to 30°. Outcrops
occur along a ravine
for about 1200 feet up
& then the outcrop can
be found on the steep
slope with the hammer
pick. ~~(300)~~

2040 ft.

(c) ~~at the~~ first summit
of the ridge a
~~thin~~ bedded hard,
dirty gray to brown
fine grained sandstone
occurs that becomes
a more or less shaly
sandstone. weathers

61

184

5

920

125

1045

35

103

515

70

585

55

170

850

115

6

buff light grey +
reddish-brown

1045 ft

These beds form the highest point on the ridge east of upper Deep creek.

d) Hard compact siliceous (thin bedded +) & shaly beds. Weathering lighter gray + much like 8

dip 20° E.

St. N. & S.

The beds 1- of section Toward the top layers 2- to 8" thick occur.

~~(103)~~

585 ft

e) Shaly rds & sil-rock mixed. ~~(170)~~ 965 ft

Strike has swung around to N. 60° E.
dip 15° S.E.

$$\frac{40}{14}$$

48

200.
25

240
3

f. Gray & greenish
gray - platy, hard
sandstone.
Mud cracks & mud
markings -
This bed is unlike
any seen below, 225 ft
~~(40)~~

12) Siliceous, smooth
shale. Greenish & grey.
Occasional layers of
light gray
quartzitic sandstone
4 - 8 in thick
A little impure calcareous
matter, very siliceous &
appears as brown weathering
interbedded strips - Grey
on fracture
Toward the top the
quartzitic sandstone
predominate. The sand
was well washed &
looks like that of the Cambrian
sandstone.

275

8.

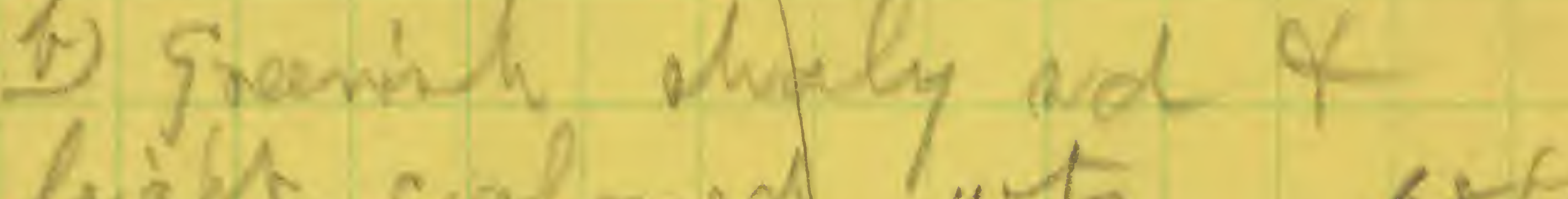
Summary of Chamberlin formation –
Note that 11 forms Gross Int;

1.		✓ 795.
2	Eruptive sill	✓ 170.
3		✓ 135.
4	Eruptive sill,	✓ 160.
5		✓ 1025.
6.	Eruptive sill.	✓ 395
7		✓ 1235
8		✓ 70.
9.		✓ 795
10		✓ 330
11.	a)	✓ 305
	b.	✓ 2040
	c	✓ 1045
	d	✓ 585
	e	✓ 965
	f	✓ 225
12		✓ 275
		10550

12

Callen formation;

1) a) Basal limestone bed ~~layers~~ resting on very slightly irregular surface of greenish sandstone. This ~~layer~~ bed is made up of a laminate algal deposite of 3 or 4 layers more less interrupted by the algal ~~gro~~ deposite



(2)

b) Greenish shaly sd & light colored qtz sd 68 ft

c)
Limestone, algal bed similar to (a) 4 ft

124
255
98
250
370

1097.

30.

15
40
230
25

65.

10

d) Sandy-dark compact shaly layer 6

e) Gray, arenaceous limestone — 7

f. Same as d —

34.

g - algal lim — 3.✓

46

h. Same as d, with occasional layers of arenaceous lim 255.✓

i. Arenaceous lim 4✓

j- Same as d — 73✓

k. Algal bed. 4✓

l. Same as d — 12✓

m - Arenaceous lim 5✓

6 34

26. 170

80 25

195

200.

15

47

44

14

220

30

11

n) Same as d, passing
quickly into greenish gray qtz sd
+ Rippled marked layers
up to 3 feet thick
(44) 250-

o) Same as (d) with a
few layers of arena
ceous lime. At 35 ft
up a ~~ft~~ thin bed
of algal lime.
At 90 ft up 3 foot bed
of qtz sd — with
traces of algal formation
at top of sd.
At 195, a six feet of
alternating arenaceous
sd & shale.
At 215 ft of band
of reddish purple
arenaceous shales
20 feet.
At 255 greenish
ar-sh

(7)

115
75

30

45
2 2 5
3

6.0

16
80

1) Light sdy sh -
2) algal lm 4-
3) Like 1. 90
~~4~~. Qtz sd - 6
5) Ar sh, buff - 65
6) Red ar sh 10
7) Buff " " 40
8. Qtz sd - 8
9. Sdy sh 10
lm 6
10. Silty [illegible] algal li 31

at 370 feet a ~~purple~~ reddish-purple sh. ~~band.~~

~~95 ft.~~

370

2) a. Reddish-purple 1' = 1095
arenaceous sh. 95

b. Drab ar-sh.
in alternating bands
20 with purple ar sh - 255

C. Gray arenaceous lm. 1

d Reddish purple
shales - 95

Section cut off here
by undulations of
strata.
Traced by the upper
beds of the ~~McCallend~~
~~section~~ it was taken

(3)

up in the cliff a few hundred yards above Hunts Ranch house situated north of the Castle road.

The upper part of the ~~Newland~~ [illegible] series is as follows.

It is evident from the appearance of the ~~blue~~ arenaceous limestone & algal that ~~the~~ constant shifting of the sand caused the algae ~~tests~~ to fight for a mere existence & ~~that~~ no considerable amount of limestone could be deposited.

section on next pg.

8

14

Callen

Upper part of ~~Newland~~ ~~[illegible]~~ terrane in cliff north of Hunts ranch house.

1) Gray qtz sds with ~~shaly~~ partings of arenaceous shale. 40"
St. N. 10 W. (mag) dip 5°

2) Greenish & dirty gray arenaceous shale. 23.

3). Reddish purple ar-sh- 12.

4.) Like 2- 20

5) Qtz sd- 7

6) Ar- lm 3

7. ~~Ar sh~~ Ar. lm- alternating with sh- (algal bed at top. 6 in) 23

8). Ar sh 42

9 ar lm & algal dip 11

10. an. $\frac{15}{sh}$ –

35
7

84
420

185
556
2780
3700
3150
2630

3820
480
4300

10) arg. sh – 51
11) Qtz sd. 3 7
12. ar sh. with a few layers of Qtz sd. 46.
13. Algal fm. 4.
14. ~~Sd.~~ ar- sh. with layers of Qtz sd. 40

No trace of Greyson sh –

Spokane formation

1) Reddish ar sh. with occasional layers of reddish sd ~~48~~ 65
7

see p. 16

(16) Aug. 17/14

Spokane -

Continuation of section toward Black Butte

Reddish-purple shales, at 259 ft up 3 ~~sas~~ thin bands of yt ss - going to form 3 thin cliff scarps on N.W. slope, below Cambrian Flathead sandstone

at 3630 556 layer of calcareous ss, 6" thick —

Total to base of Flathead ss. 4300—

Aug. 19/14

Collen formation.

Name proposed for a series of quartzitic sandstones and arenaceous shale ~~be~~ above the Newland formation & beneath the the Greyson formation. Type locality at junction of Deep Creek and Collen Creek just above Glenwood 12 miles directly east of Townsend. Broadwater Co., Montana. Geol. age Algonkian. A formation of the Beltian system.

Thickness on Deep Creek
1075 feet

Fossils - Large *Collenia*.

3 8-14-14,

~~13) Dark siliciaus shale with arenaceous laminae in lower 12 ft.~~

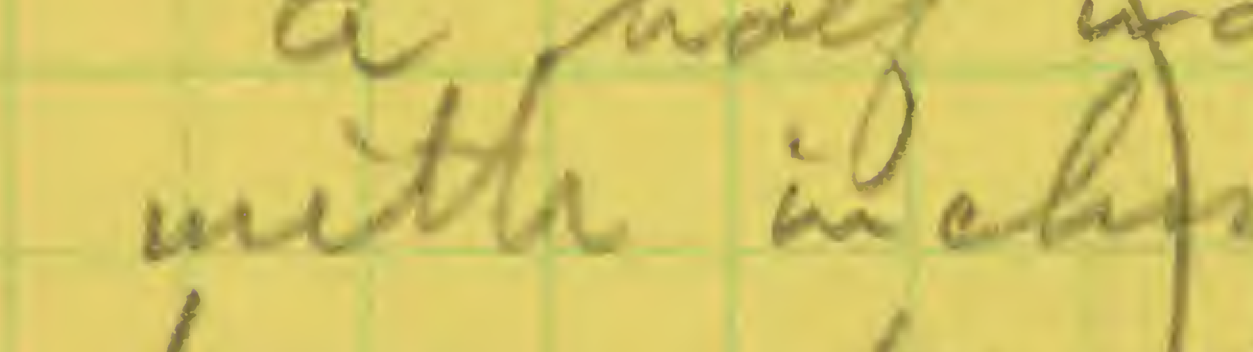
New formation ~~32~~

1) Dirty brown, hard sd in layers 3-to 7' 6

24) Thin shale, sil & cal. dark, gray clean & passing up into arenaceous sh. 165

37) Dirty gray, hard sd with shaly partings of from a few in to 8 ft. A half washed sd with inclusions of ~~fragments of shale~~ small pebbles of sh & pebbles of brownish sd up to 8 in across.

Dip 85° Forms projecting walls on side of canyon



35
5

380
50

430.

24
73
365
50

90
450

65
190.

950
1.25

1075.
510

565

4) at 415 ft a small canyon is worn between the nearly vertical hard sds.

430.

5) a ~~Brown~~ Dirty-brown sd. sh + thin bedded. (Dip. 65° St. N. 20° W.) ~~That~~ passes of into hard layers interbedded at 510 ft up.

(b) The hard layers + sd sh continue up the sides to Canon Deep creek to nearly Rosser Gulch — above Glenwood —

a = 510.
b = 565 1075

Grey son formation as follows

~~1) Calcareous shales.~~

455
2275
325

2600
260

781
3905
520

4425

~~125~~

2

53
158
790

1055

895

40
125

625
85

710

7~~8~~0

50

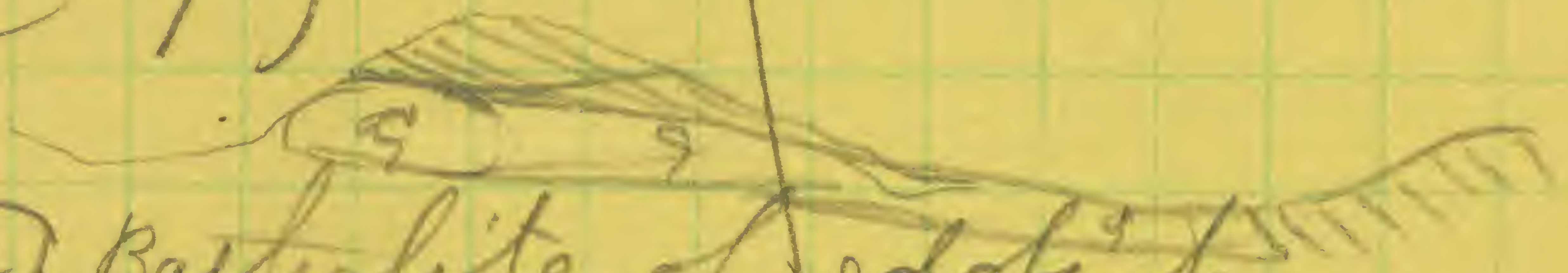
849
781

68

9460
1720

7~~4~~0

Section from ① Oct 10th/14.
Mt. Edith, Big Belt Mts
St. of direction section East 10°20'S.
(mag.)



(a) Bathalite of reddish granitic rock. (

Algonkian – Section going up

Chamberlin formation

1. Compact, hard ~~siliceous~~ grey & thin bedded siliceous – almost jasper rock passing gradually into a fine, hard sandstone (140)
2. Sill of eruptive (43)
3. Similar to 1. (36)
4. Sill of eruptive
5

36

46
140
700
95

540
185
2700.
-360
88 3060

181
905
120
1025

24
120
15

70
25
350.
45
4

112

140

150

2/ Oct 10/14

The batholith of Mt Edith extends around (on the north side) under the shales on the summit & is extensively cut into by the great cirque on the east & S.E. side. On a ridge running east the siliceous beds of 1. of section on p 1 rest on the batholite & dip east.

1. = 1 = (140) — 795"
2. = Eruptive (30) — 170
3 = Same as 1 (24) 135
4 = Eruptive (28) 160
5. Dark siliceous shale 1025
6. Eruptives (70) (48)
7. Dark siliceous shale – passing into thin bedded sil rock like 1 and with interbedded ~~(118)~~

19
(58
290. 39
40
330.

73
218
1090
145
1235

195
140.

140
45
700.
95

23
70
47
350.

Aug. 29/14.

Algonkian section
East Gallatin valley
up. from river level (On back:)

1) a). Eruptive 28 ft ✓
b). Calcareous sh 6" ✓
c) Eruptive with a little dark fine arenaceous shale - 91 ✓

125

No 1. is the thickest of the eruptive beds. It is bedded volcanic ash-like deposits with frequent lentiles of shale & thin bedded sds.

2) Thin bedded & shaly dark gray compact lm. Often arenaceous St. E & W. Dip: 25° N.

134 ✓

Section measured from north side of East Gallatin river beginning at water level & carried north up over hill & then by following strike of well exposed beds to hills west to a large gulch that penetrates north to the Flathead formation which forms an E+W ridge at its head.

14
44
47,
220
18
23
115
11
20
100
1

2 Aug 29

3) Eruptive 58✓

4.) Cal - lm & sh. forming thin layers of gray, sometimes slightly argillaceous platy limestone. In places the layers ~~are up~~ thicken up to 6" in thickness - Mud markings & rarely ripples indicate shallow water deposits

5) Weathers breaks up in thin large plates. ✓ 255

5) + at 130' traces of algal deposits (thinly laminated arenaceous sh - Grey, brown, purple. 16✓

6) Interbedded lentile of eruptive (ash) 4✓

7) Calcareous shale with a few thin layers of gray lm. 112✓

~~90~~ ~~18~~

18,

~~23~~ 45

13.

65
9

20
2 6
4 2 6

25
3

---

ah

3 : aug 29th

8) a/ Eruptive - 33.

9) a/ Cal - sh.
at 102 ft from base
a layer of eruptive
1 foot thick occurs 102

b) Pinkish fine arenaceous
shale. 74.

c) Eruptive 29

d) Pinkish shale similar
to b) 11

e) eruptive - 3 6

f) Similar sh - 8 6

26 1

9: Eruptive with
two partings of sh 17

10) Sh - like b
at 5 ft. bed of
eruptive 4 ft - 76

1 - 4

" 1 ~~28 - 4~~

3.10

algal beds - 2.6

Shale 23.

45.
6
51

25.

125
34
58
275
112
278
76
47
1005.

4

11) Emptine

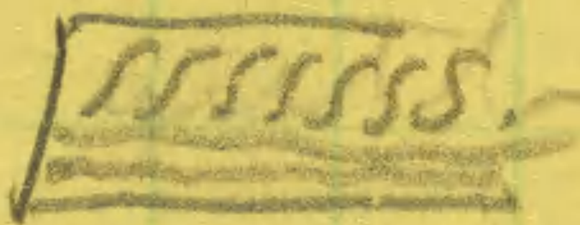
aug 29/14

47 ft

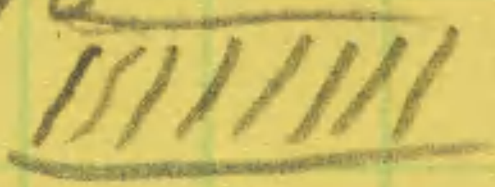
100 5 ft

12) Cal-
shale passing into
thin bedded
gray ~~lime~~ fine
grained lim. with
algal beds - 5½

a) Shale 23 ft.
algal layer 4 in
from base -



1 in thick -
Laminated algal
layers - 5½ in
algal layer 5/8 in



Laminated layers
with traces of
algal forms - 2 ft 6.
at 3 ft 4 in from
base a thick irregular layer
(8 to 12 in) is made
up of a very coarse
irregular algal

~~3 ft 4 in~~

Locality (4002)

18
95

17

3

55
7
3
65

26. 6

~~14~~

7. 4

28. 4
5.

3.4
1.
28.4.
1.4

34.

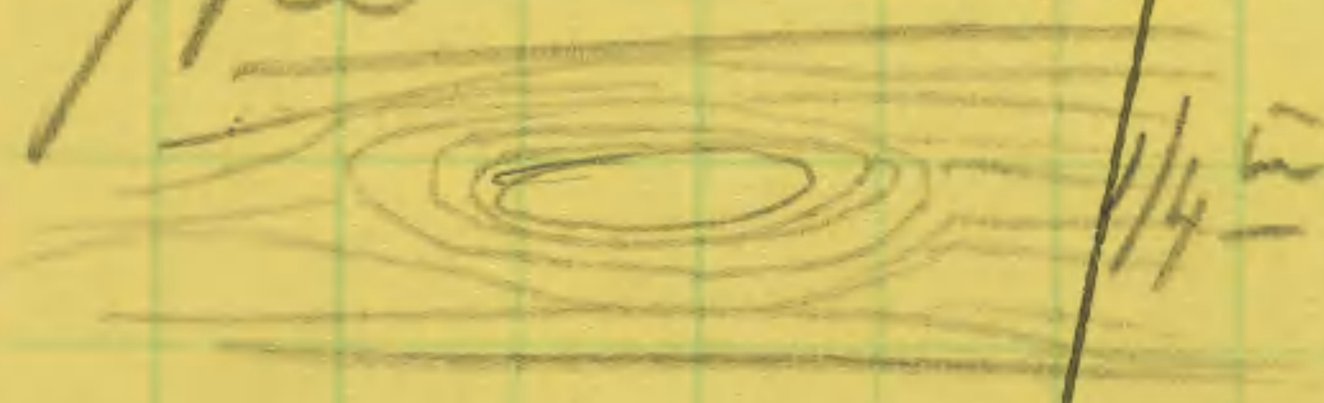
5

aug 29th

growth with irregular nodular interfaces. 1ft

Thin layers of lm with (traces) of algal growth — 28ft 4in

Thick algal layer with large laminated type 16 in



(1/4 in lamellae)

34 ft.

13) a Pinkish shale very fine + siliceous or arenaceous — 18

~~14~~. b Emptie 13

~~15~~ c) Pinkish sil sh — 65

d) emptie — 6

e) Pinkish sh 11

113

~~13~~/14. Thin bedded lim ✓ 5'-4"

45.

3 - 4

10. - 4
1

15
7

39.

15) Pinkish sh - with (two layers of eruptive near the base, occasional layers of limestone 1 to 4 in thick - Also round ~~lm~~ lenticular limestone "concretions). 107 -

16 a) Eruptive - 17 ±

b) Calcareous sh with thin layers of lm 21

c) Eruptive 7.2 in ✓

d) Dark sh with small lentiles of lm 9$^{\underline{8}}$ ✓

e) Eruptive 52' ✓

f. Cal - sh + lm (Partly concealed) 39 ✓

g) Eruptive 9$^{\underline{6}}$ ✓

h.) Cal-sh thn. 14$^{\underline{4}}$ ✓

45

19.

7

Aug 29 - /14

1) Emptive -

17)

187.4.

17) Gray lm in layers algal bed - 7' 8"

18a) Emptive - 1'-4" ✓

b) alternating cal-bed & emptive (Partly covered) 51' ✓

c. Thick layers of lm, with irregular layers of chert in them [illegible] & [illegible] of shale & a coarse algal bed. 14 ✓

algal

d

a) Emptive with lentils of algal lm - midway 1.9 ✓

85.4

13) f9) algal lm in irregular layers - 6'-4" ✓

Coarse irregular algal lyke

$\frac{320}{27}$

200.

$$\begin{array}{r} 40 \\ \hline 18 \\ \hline 6. \\ \hline \end{array}$$

22-

110

$$\begin{array}{r} 90 \\ \hline 30. \end{array}$$

8)

Aug 29/14.

20) Pinkish sh as partings with eruptive beds. 225.

21) Thin bedded platy lm - passing into calcareous shale, with occasional layers of eruptive - 237 ✓

22) Eruptive with partings of calcareous sh & an occasional layer of lm.
Lm - nodules in shale

102. ✓

9) 23 a) algal lyr with partings of Cal - sh & 41 ✓
The algal form is very coarse & in large masses - 18 in by 6 feet)

~~20~~ 1
36

180 25

~~19~~ 5
96 9 2
1

23) 9. Aug. 29/14.

b. Eruptive 3 ft ✓
44

c. Thin bedded lm 7' 8" ✓
d. algal bed - 1' 2" ✓
e. shale 2' — ✓
f. shaly lm. in thick layers. 3' 6" ✓
g. shale. 9. ✓
h. cherty algal lm. 1' 10" ✓
i. Eruptive 11' 6" ✓
j. Lm. in layers. 1in to 6in 22' 6 ✓
102.8"

24) a) Eruptive with a few thin lentiles of shale. 204' ✓
b Arenaceous sh. 34' ✓
c. Eruptive 207 ✓

35.

13

40.

25

5

4

31

15 5

20

175

10 Aug 29/14

24) d
8) alternating arenaceous sh + amphitine 39 ✓

7/25) Banded cherty lim- in layers 1/4 in to 5 in thick, 17 ✓

6/26) Similar to 24d. 22' 6" ✓

5/27). Arenaceous limestone nodules in purplish arenaceous sh — 8' ✓

4)28. Similar to 24d 46. ✓

3/29) ~~Buff~~ + greenish ~~calcareous~~ arenaceous shale with a few layers of limestone - One bed of amphitine near base 175 ✓

2/30 Emphtine — 28 ✓

1)31.) Purplish arenaceous shale 22 ✓

Aug. 29/16

The section is capped by a massive bed of coarse reddish sandstone of the Cambrian Flathead formation –

Fine quartz pebbles & cross bedding mark the lower beds of the Flathead.

Aug. 29/14.

Eruption of Algonkian
Gallatin section –

Dark bedded contemporaneous deposits made from a volcanic sand or ash spread over the sea bed. The currents also spread fine sand over the volcanic deposits & during quiet periods calcareous muds were deposited & algal growths flourished. Sometimes as a small mound (or hollow a few feet in diameter.

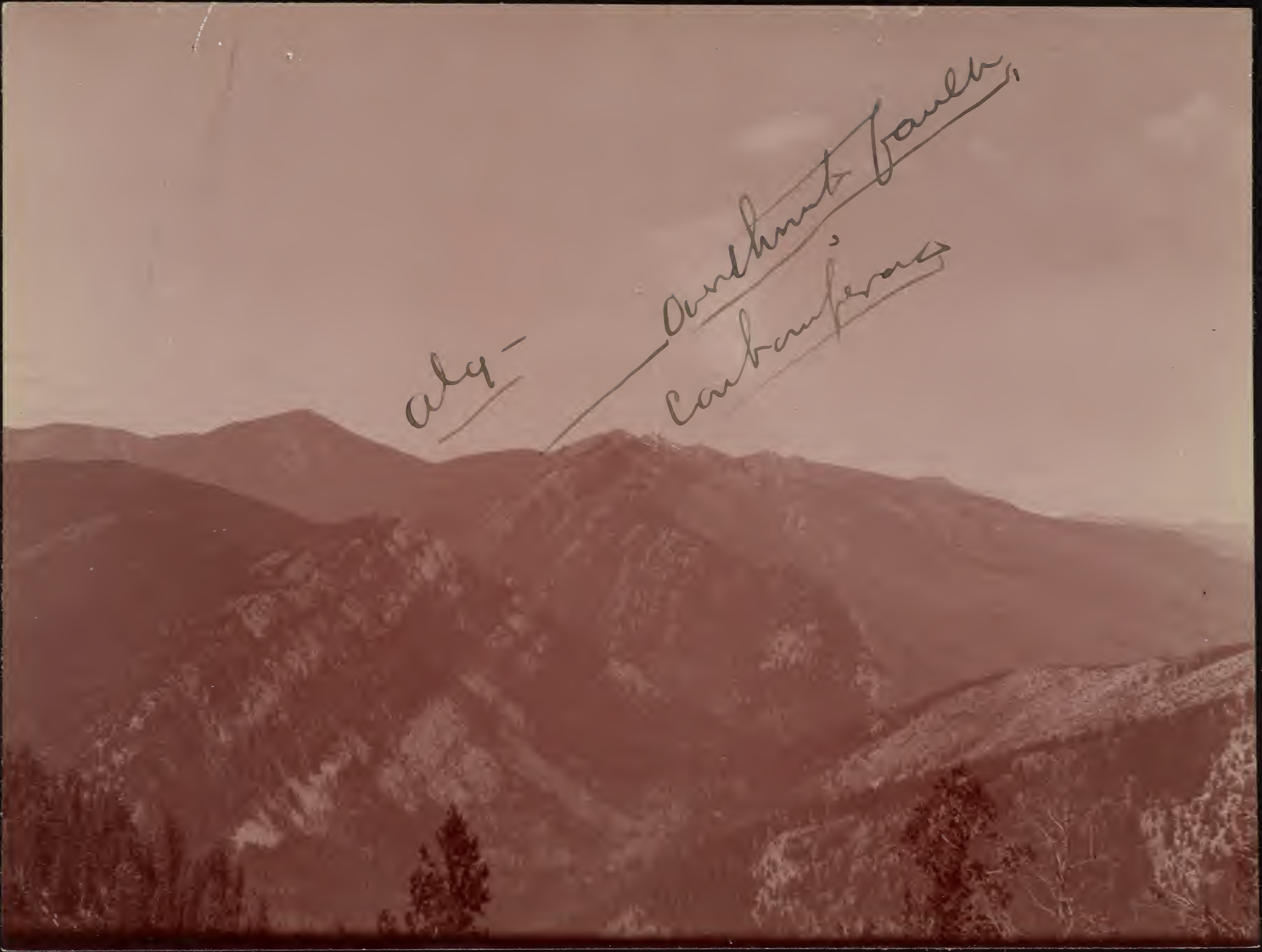
Sugarloaf Mt. from
Danaher ranch,

Ovando - quad-
rant.

A mass of Cambrian
lm + sd - resting on ~~I~~
Algonkian rocks

USGS

June/05

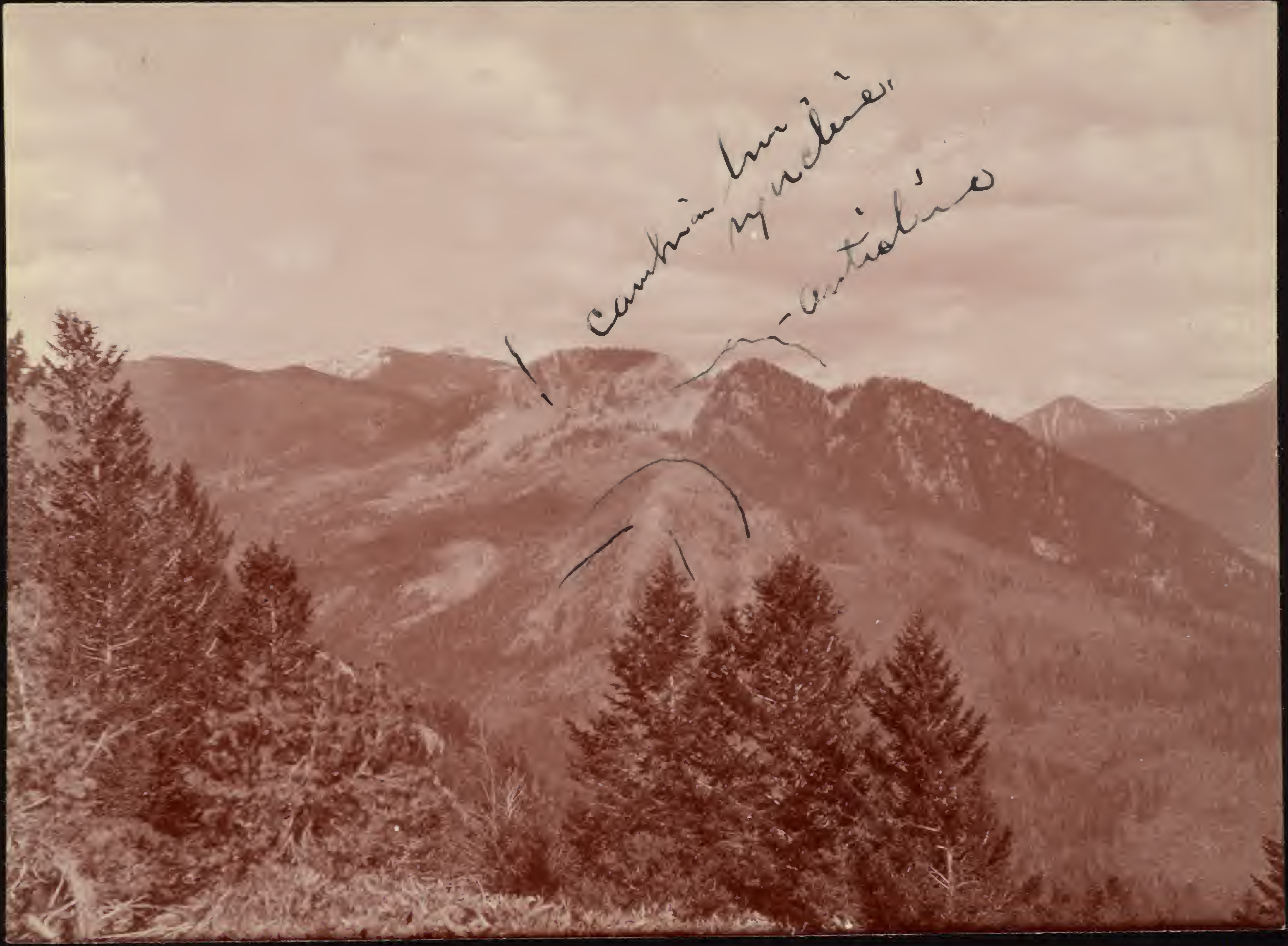

alg –
Overthrust fault,
carboniferous

h C

67

East end of Jumbo Mt. anticline - on Spring creek above Danahen creek - Ovando quad Mont.

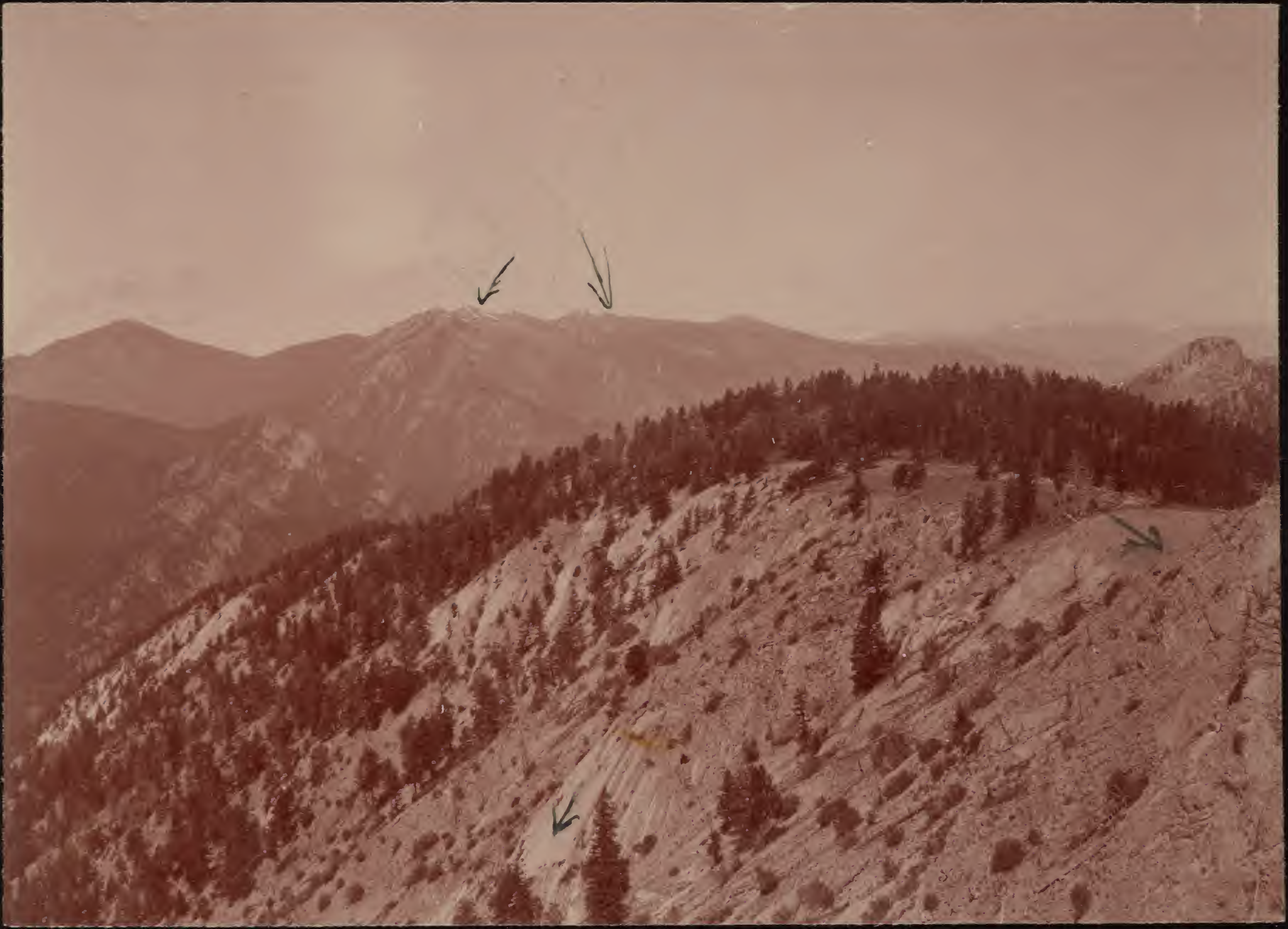
2, neg,


cambrian syncline
anticline

l

65

64



Mt Jumbo anticline
on ridge east of
Danahen creek –
Quando quad-
rant –

usw
July 1905

4. Neg.

Aug. 13/1900

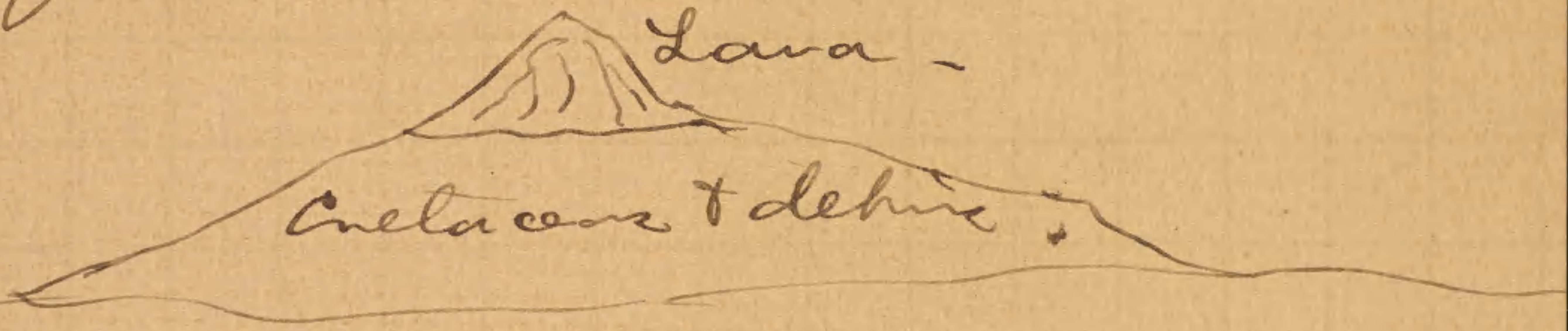
Haystack Butte.

Top 6525

Base of
lava cap.

South base 4800.

A volcanic neck left
by erosion, see photos
for outline.

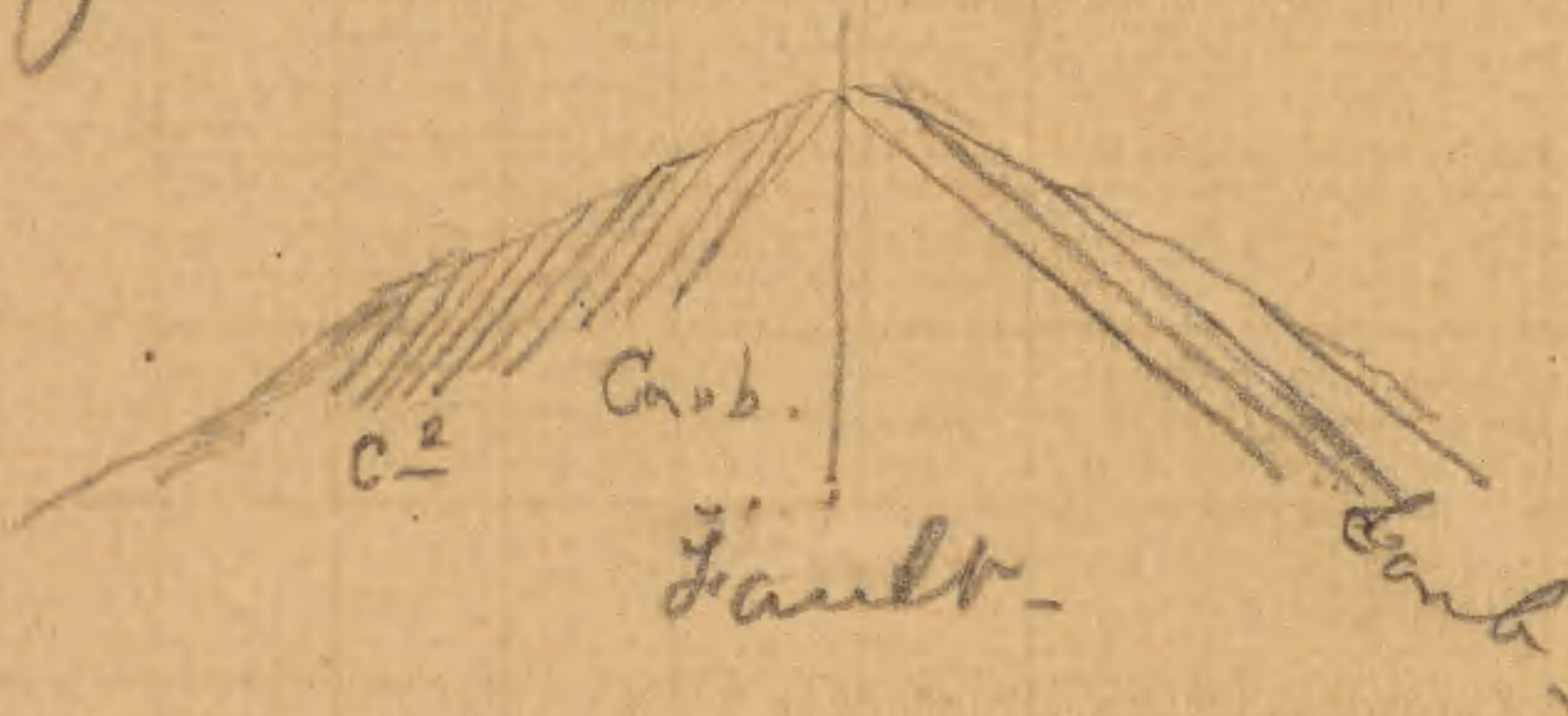


June 29th 05

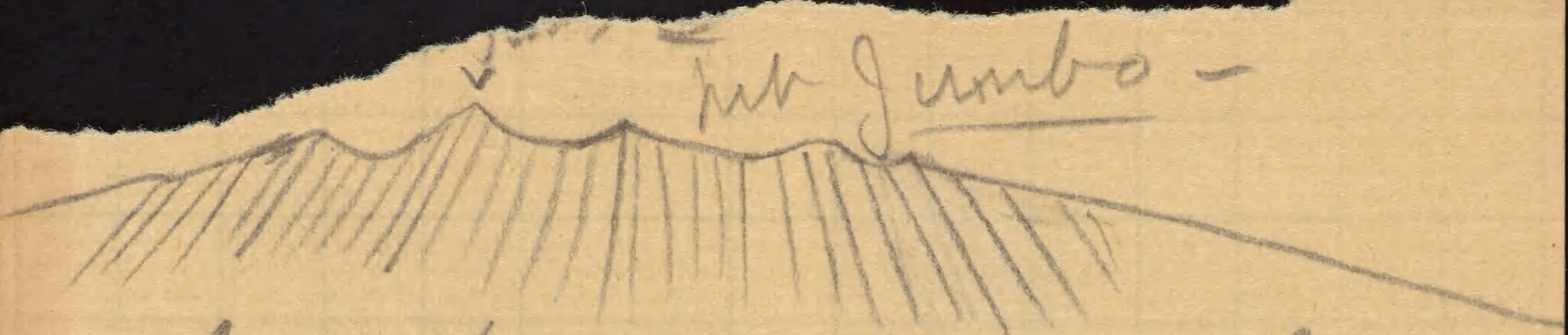
Mt Jumbo anticline

Danaher Creek / Lookout ridge

Ridge between Spring creek + Rapid creek on S. side of Danaher creek.

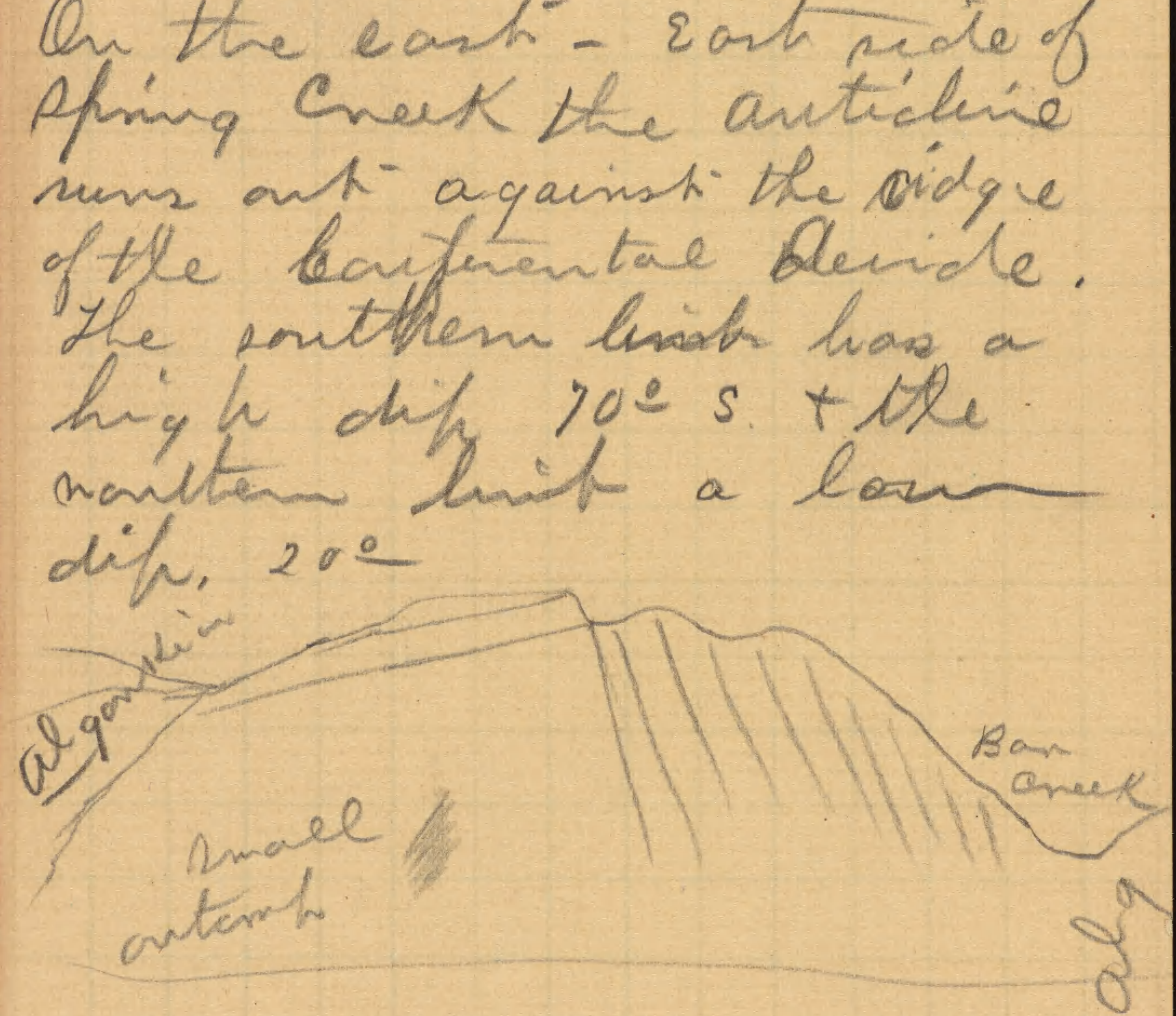


On west side of Danaher Creek north of Foul Hen creek the limestone of Mt-Jumbo dip S E, 70°. St. E, 15° to 20° S. On the ridge east the dip at Foul Hen Creek is 50° S. On the long ridge north from Mt Jumbo the limestone beds of the first point north on the ridge are vertical on the next, + rounded point the dip is north 70° + still further north 50° to 60°.



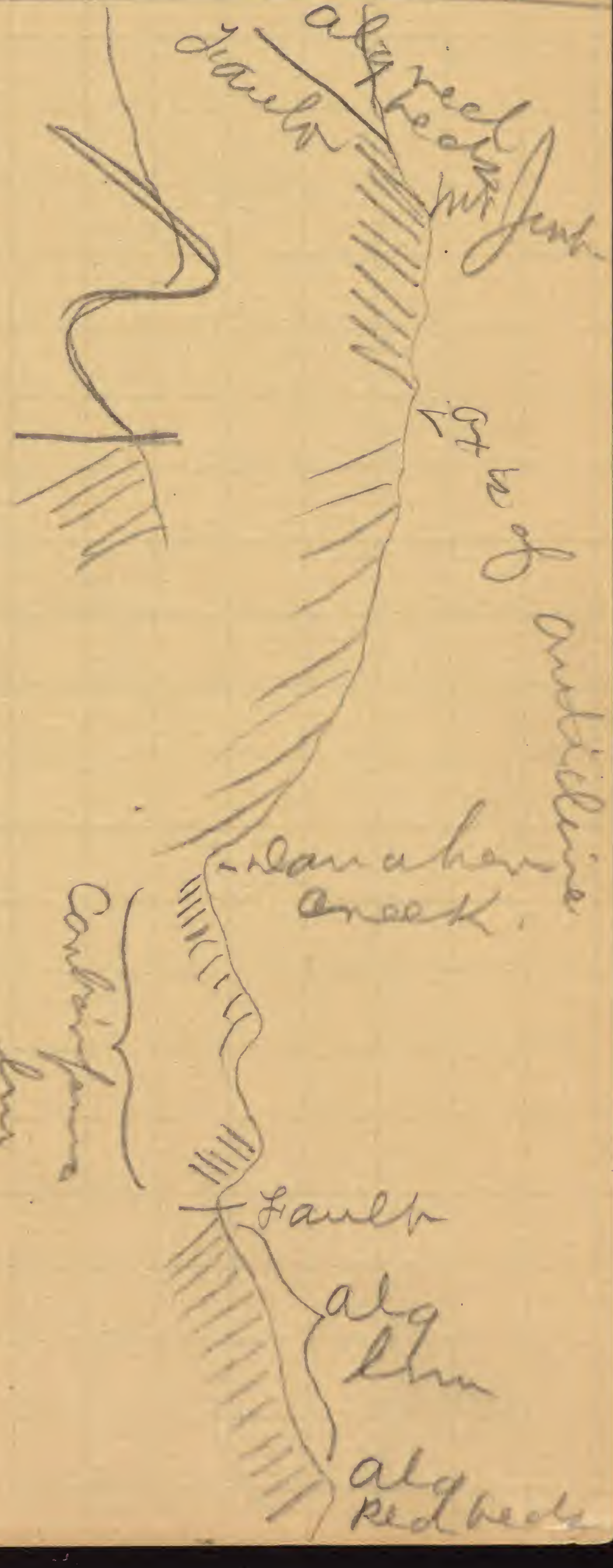
See Kodak views - also 8x10

On the east - East side of Spring Creek the anticline runs out against the ridge of the Continental Divide. The southern limb has a high dip 70° S. & the northern limb a low dip, 20°



July 2d/05

Mt Jumbo anticline



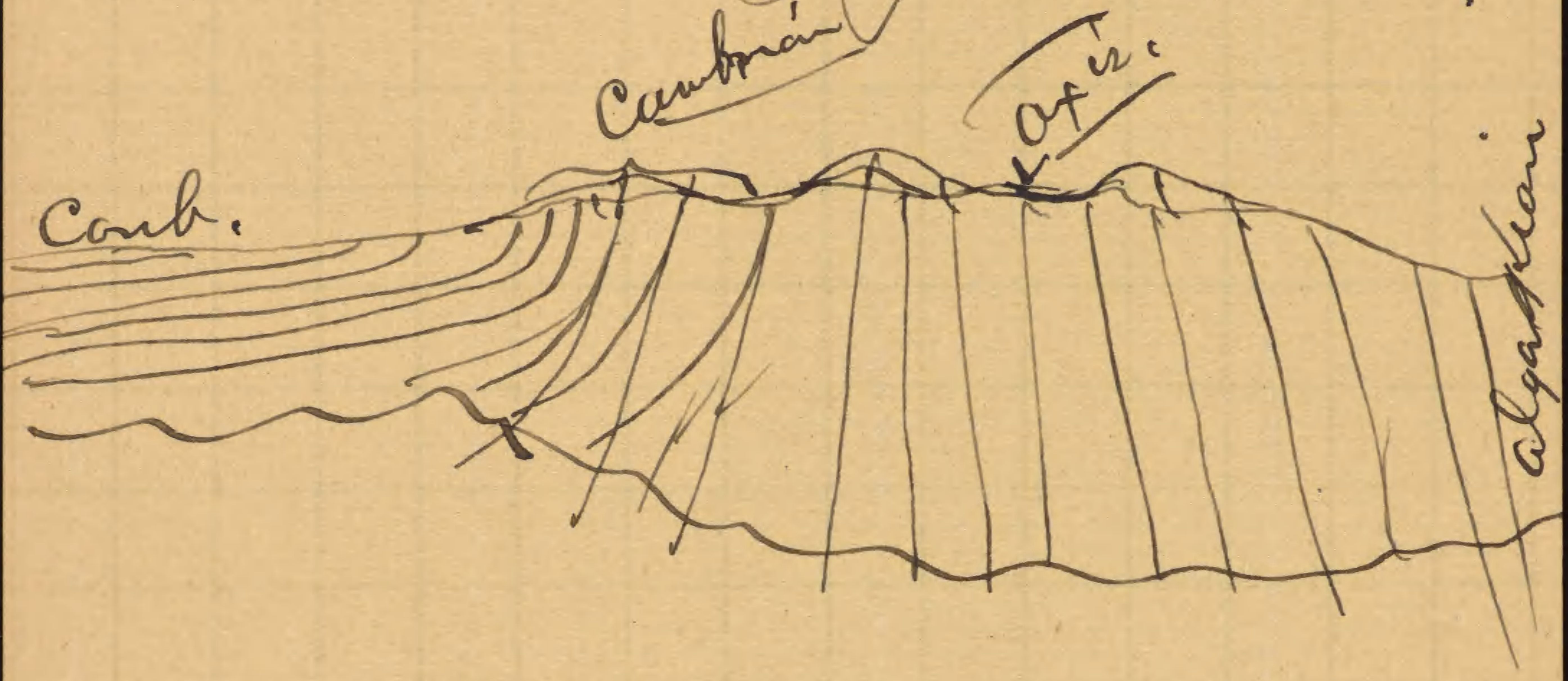
$$\begin{array}{r} 65 \\ 5 \\ \hline 325 \\ 45 \\ \hline 370 \end{array} \qquad \frac{520}{45}$$

$\underline{65}$

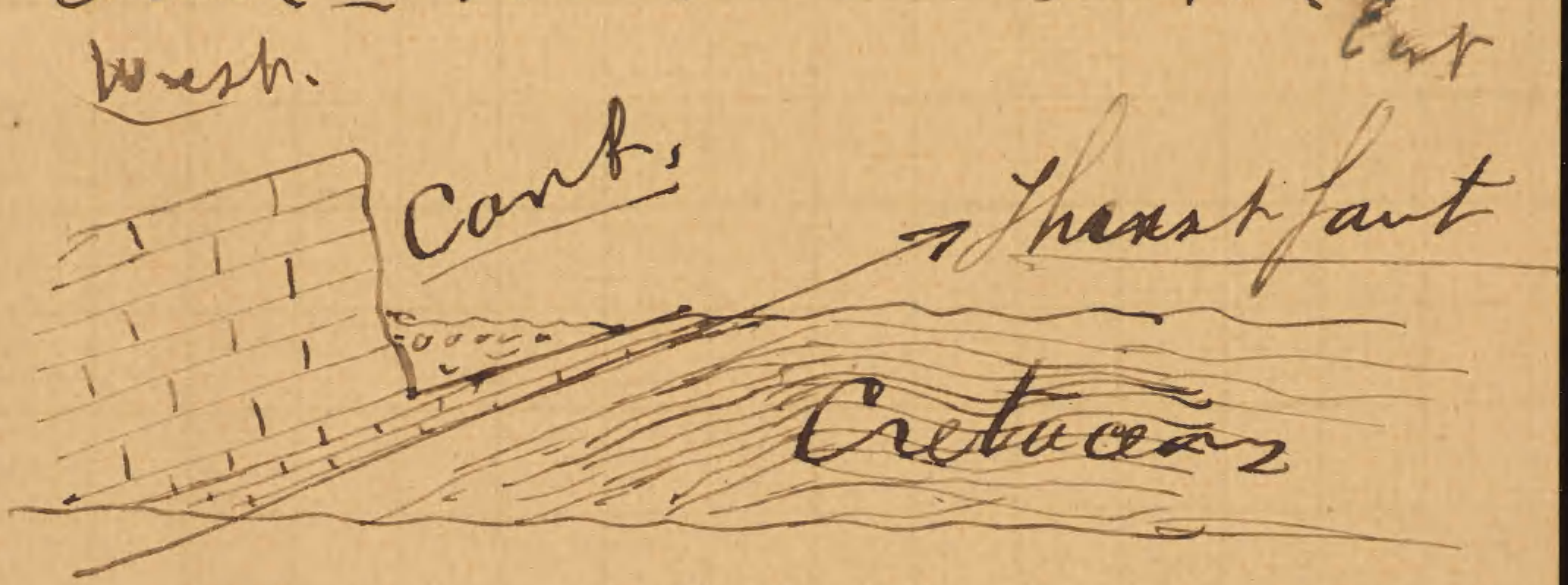
Mt Jumbo anticline.

July 23/04.

seen from the west side of Mt Jumbo, the section is as follows,



Sun - river N. Fork



At entrance of canyon in lm.

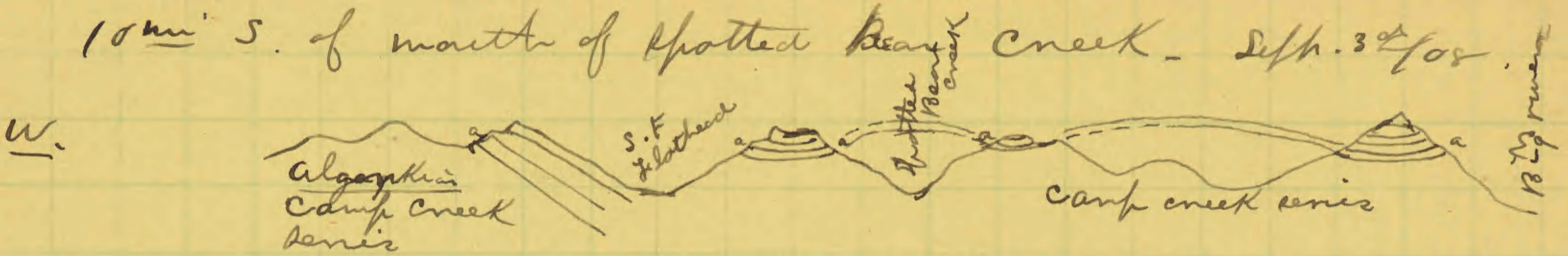
On Smith Creek just below Whites sawmill about 8 mi N. E. of Mr. Dearborn the massive lm - is pushed over the Cretaceous sds & shales as on Sun river

---

Middle Cambrian.
Scapegoat Mt.

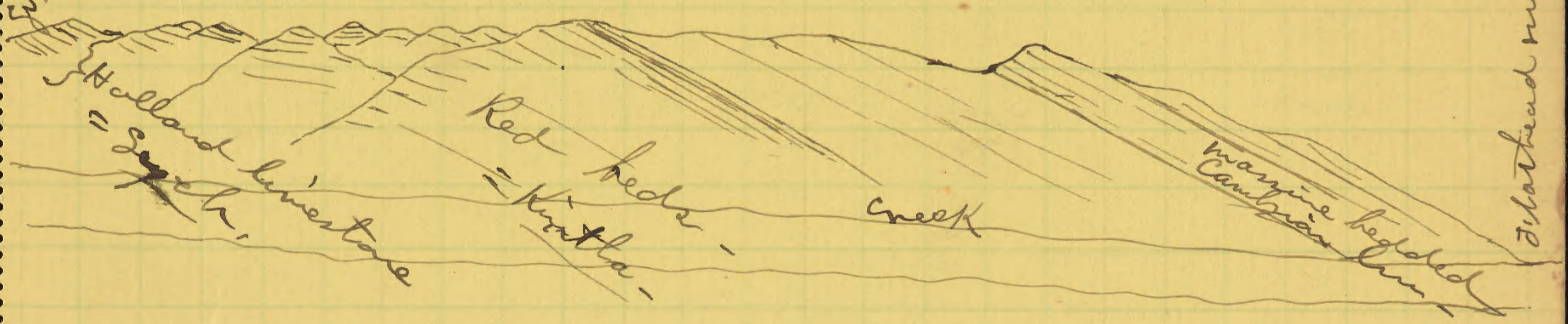
Scapegoat is formed very largely of Cambrian limestone with a capping of Carboniferous lim. Below the limestones on the slopes the Woolsey shale & Flathead ~~ta~~ sandstones crop out in many places. The section is essentially the same as that on the ridge west of Gordon mountain.

10 mi. S. of mouth of Spotted Bear Creek – Sept. 3d/08.



From Pentagon Peak west the high ridges are capped by synclines of Cambrian limestones with Carboniferous above when not removed by erosion – Viewed from the north on line of lower portion of Spotted Bear creek the Camp creek (Algonkian gray & red beds) series are like the waves of an ocean with the gray white limestones capping the summit of the waves – North of Spotted Bear creek the limestones are ~~not~~ unknown except along the line of the main range on the west side of Big river (Middle Fork of Flathead.)

Profile of ridge on north side of Little Salmon creek. Lewis & Clarke Forest Reserve. } Aug. 19/08.



√5 Greenish sh

√6 Gr argl. sh. & shaly lm

√22 ft. Gray arena lm. cherty shaly & bedded

√53 Thin bed. & greenish sh.

√23 Thin bedded

√1 Greenish sh & lm

√16 Thin bedded lm

√5 Shaly lm & greenish sh.
Shale (fossils)

√28 Lower Massive bed. lm

√~~12~~ 2. Purple & greenish argl
sh with some arena/sd
2½

5½ Arenaceous sh.

11. Gray sd & fine congl.

Ft. of section –

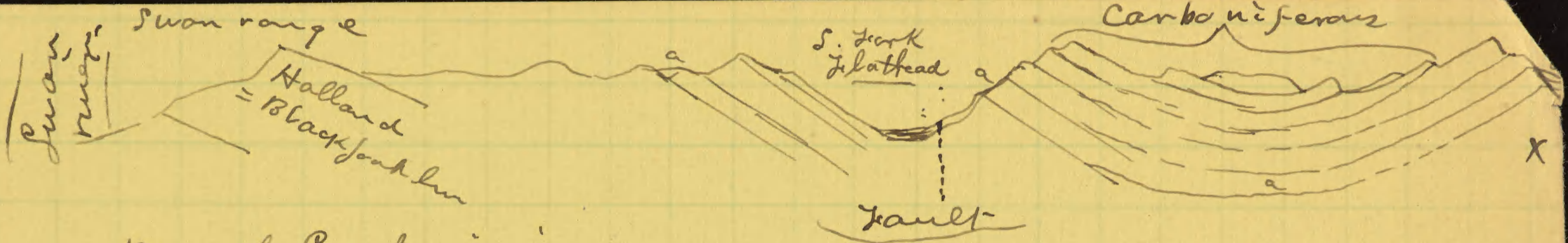
√ Purplish lm – (comes below)

√ 10 Greenish shale & lm (fossils)

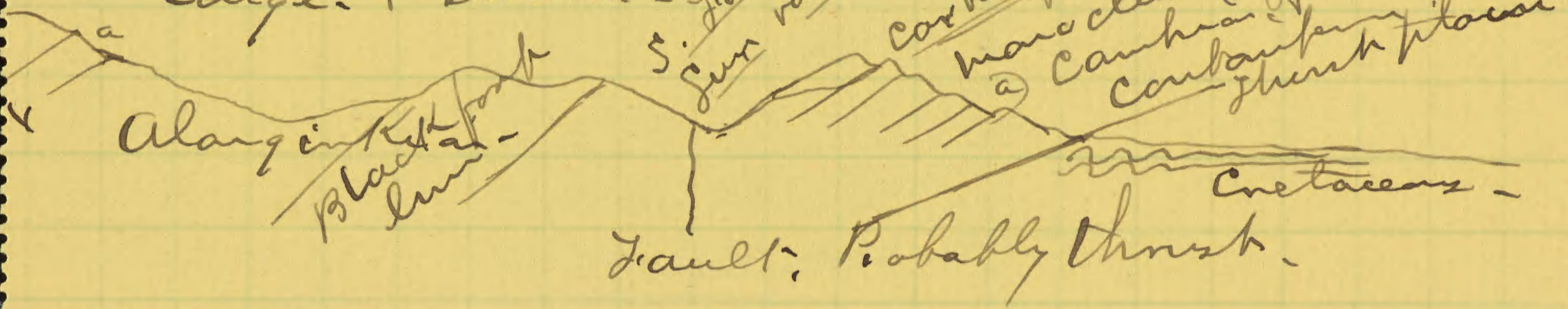
√ 12 ft massive bedded purplish
lm, breaking into thin irreg-
layers

24
120'

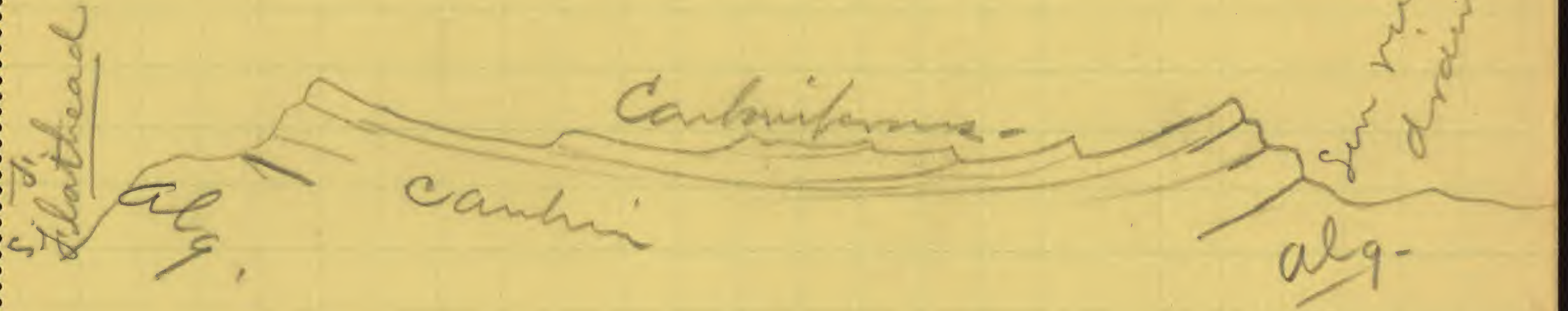
Head of White River

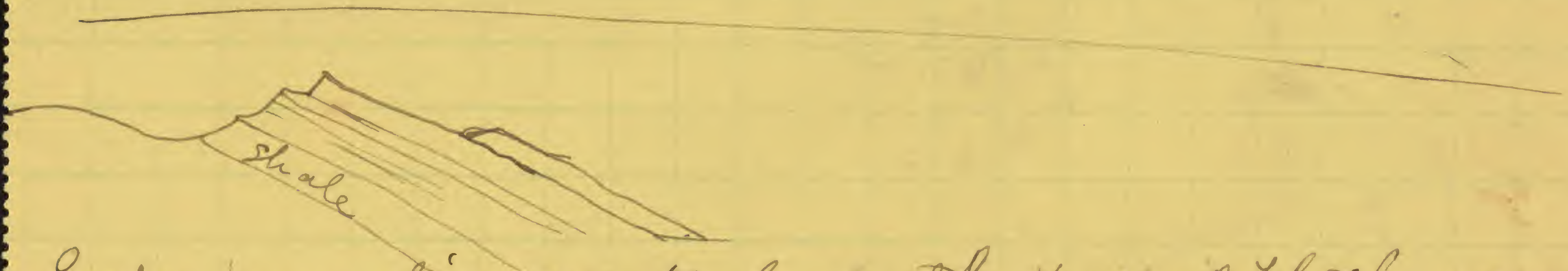


a = Base of Cambrian in Congl. & shales –



Looking north from Aug. 28/08
Continental divide at head of White river





Gordon monocline west of South Fork of Flathead river from Gordon Mt. to 4 mi. S. of Spotted Bear creek.
See next pg.

Aug 25/95 -

Middle Cambrian of the Little Belt Mountains Montana.

The base is formed of a massive bedded, hard compact gray to buff sdstn passing above into a thinner bedded & shaly sandstone. This is succeeded by shales (sandy shale) carrying Olenoides Bathyuriscus & Ptychoparia — Thin beds of limestone appear in the shales & gradually replace them in thick bands of layers usually from 2 to 4 6 in thick. From two to five hundred feet of the limestones are brecciated & this continues ~~to~~ in nearly all the ledges to the summit of the

M. C. Cont'd (2)

M. C. terrane.
See Weed's section —
" Peal's " " —

No. 168.

About 300 feet above devide (east) on road from Neihart Montana to Sheep Creek valley. upper portion of Middle Cambrian. in brecciated lime-stones. The limestone has the appearance of having been brecciated before consolidating + at time of deposition. The layer of calcareous mud that hardened when the tide was out, was broken up by the incoming tide + the fragments heaped together - many of them being rolled & rounded

Presumably Pilgrim

Aug 25/95

9—161.

~~5K~~

UNITED STATES GEOLOGICAL SURVEY.

SURVEY OF THE

In charge.

No. Name: Middle Cambrian

LOCALITY 13 mi S. of Neihart Mont
1 mi below divide on road
to Woolsey Montana.

Collector:

Date: Aug 25/95
Note Book: 169
Page:

Memoranda:

Weed. Weeks, C.D.W.

No. 168. Near road about 12 mi S of Neihart, Montana (Road: Neighart to White Sulphur Sprgs) Lower portion of limestone beds of Middle Cambrian ~~beds~~ series.

Billingsella — sp.?
Kutorgina —
Ptychoparia —

Aug. 25/95

No 170.

Aug 25/95

A lower horizon than 169 - about a mile lower down the canyon valley -

Hyolithes gregaria? occurs in immense numbers ranging thro several feet of lime-stone.

Billingsella —
Kutorgina —
Hyolithes —
Bathyuriscus —
Ptychoparia —

170a

Lower portion of lm. about 25 feet below 170.

No 171   Aug 28/95 –

Purple & green shales
beneath 169 & 170.
Collected an hour
with Meeks & Weed –

Bathyuriscus
Olenoides?
Ptychoparia –

~~171a~~

1 7-25, 1900.

Cambrian.

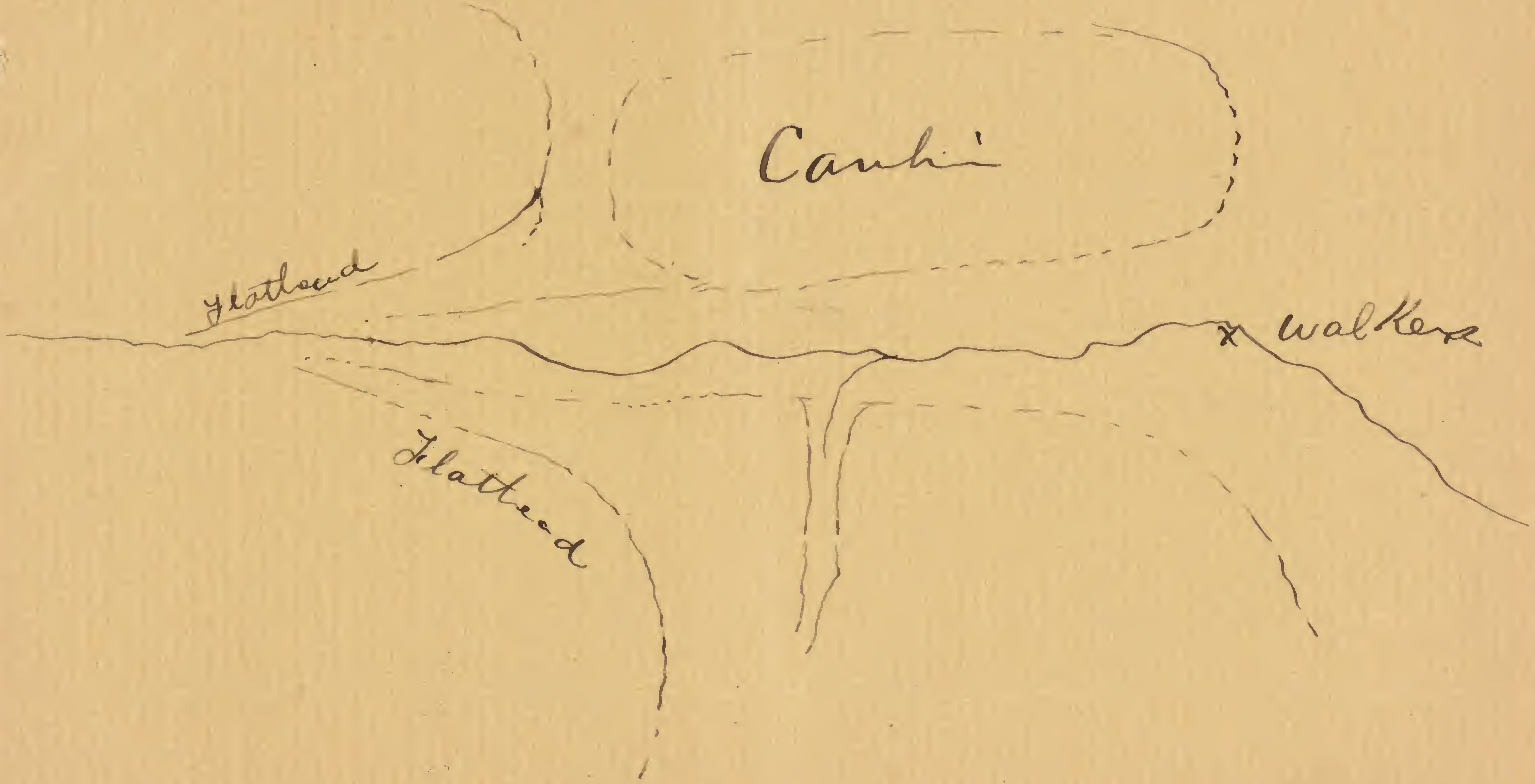
N. Fork Dearborn river 4 mi above Walkers ranch north side.

Algonkian. Belt terrane - a Empire shales. Est. 200 - b Green & purple sdy sh - beneath the Empire series as at East Helena.

St. beneath Cambrian sd - E & W. ∠ 20° S.

Belt rocks form the canyon bed up 3½ miles above Walkers. Also south side ridge to Cambrian west of first stream entering from the south( ) On north side a ridge of Cambrian rocks rests on the belt.

(Over)


Cauhi
Flathead
Flathead
x Walker

Cambrian - 2. Dearborn -

Section begins 4 mi up. canyon of N. Fork of Dearborn river. (4 mi above Walkers ranch.)

Flathead sandstone.

St. N. 70° W. ∠ 20° S.

1a Massive bedded, coarse - more or less cross-bedded light grey sandstone. Fine qtz congl. in flat places. 80-

1b Thin bedded sandstones with partings of dark arenaceous shale. Fossils. Many varieties of annelid trails. Footprints of trilobites. Cruziana (wh may have been made by trilobites) (see collection locality 240 of CDW).

70-

Wolsey shales.

2a Greenish, purple & dark grey argillaceous

Cam— 3 Dearborn

shales with thin layers of sandstone & arenaceous shale. 190.

Fossils (Obolus (Lingulella)
Ptychoparia.
Asaphiscus—

3. Meagher limestone.

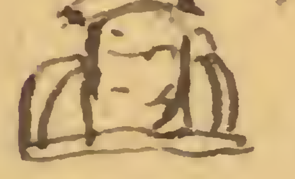
Massive bedded, fine grained, grey lm. that breaks up ~~into~~ by weathering into thin layers (1/4 in to 2 in) that have a very irregular surface marked by a thin buff-colored deposite that follows the annelid burrows & trails & also occurs as irregular blotches on the surface.
The entire belt of lm forms (5) ~~three~~ great beds (3) that may be seen for

9½ 45

Cambrian - Dearborn-
mites in the cliffs (see photo). The two lower are usually broken down.

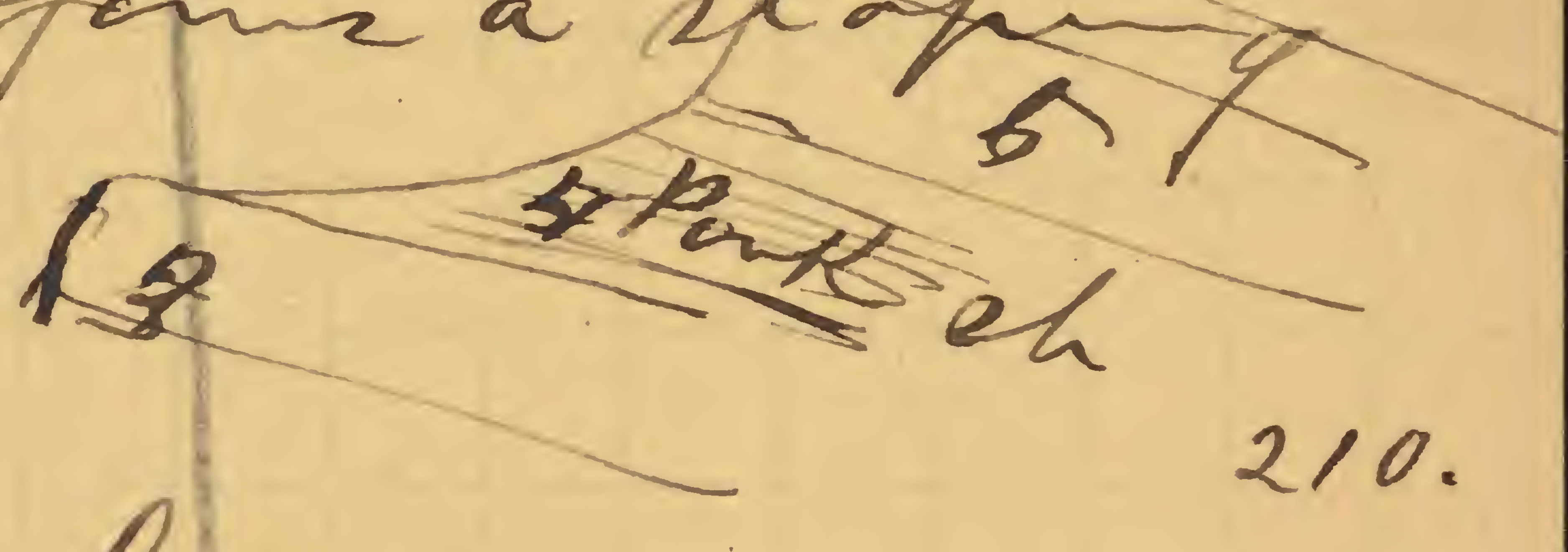
Fossils. 55.~~4~~

Annelid trails -
Asaphiscus - / see Teton list from same horizon.



Park shale.

4. Thin bedded limestone with partings of greenish argil & arenaceous shale - Limestone predominates. Easily breaks down on slopes & forms a sloping terrace



210.

Pilgrim lm.

5. Massive bedded - grey lm - similar to the Meagher lm - except that it is more of a ~~bluish~~ light - grey color near the top -

क

5

Cambrian. 5. Dearborn

Fossils. Annelid trail & fragments of trilobites Asaphiscus

130.

Dry Creek shale

6.

150.

Yogo limestone

7.a St. N. 79° W. 7-10° 15° 20°

Massive bedded grey-lim that breaks up into thin irregular layers very much as the Pilgrim lim but not as readily. Becomes quite arenaceous near the middle portion & more massive

120
600

bedded for a short distance when it again at ~~about~~ 200 feet up has the character of the lower portion. At 510 feet up a band of thin-bedded oolitic layers occurs in wh. fragments of trilobites are numerous - also a small Obolus This type of lm - interbedded with the irregular thin bedded bluish grey - continues up 170 feet = 680.

7th. St. N. 70° W. > 30°

Greenish & grey thin bedded lm - arenaceous shale & thin layers of greenish sd - with numerous annelid trails, fragments of trilobites - 90.

$$\begin{array}{r} 770 \\ 550 \\ \hline 1320 \end{array}$$

Cambrian (7) Dearborn

7e Massive bedded, hard grey & bluish grey lm – ~~with~~ that breaks up into thin, irregular layers on weathering – yellow to buff at partings of thin layers. The upper

10 100 feet contains many dove colored lm & near the top oolitic lm – Fragments of Ptychoparia were noted about 150 feet below the summit.

550.

Total Yogo lm 1320.

Total Cambrian,

Yogo -	1320
Dry Creek shale	150.
Pilgrim lm -	130
Park shale	210
Meagher lm	55
Wolsey shale	260
Flathead sandstone	180.
	2295

The line drawn between the Cambrian & Silurian is on the change of the character of the limestone from a pure limestone to a gray arenaceous lm.

Sil-Dev.? (9) Dearborn.

1b 1a Massive bedded, light gray - arenaceous lm - St. N 70° W. ⌉ 20° S. 164

1c 1b Massive bedded - light gray, ~~banded~~ lm - that breaks up into thin & often shaly layers on weathering - 51

1d 1c ~~57~~ Massive bed light-gray arenaceous lm - passing up into a purer, slightly banded lm - 80 175 ~~[illegible]~~

1e 1d Massive bedded light gray arenaceous lm - with thinner bedded purer lm - at intervals. On the mountain slopes the massive beds form

385
320.
675
1380.

199
132
67.

66.

75
6
375

132. 44
5
660.
88
748.
75
675.

27
135
18
163
116
348
5
1740
232
1972

44
133.
5
665.
89
754.

128 42
640
85
725

10 [illegible] 1E

cliffs & the thin bedded more shaly portion slopes. 245

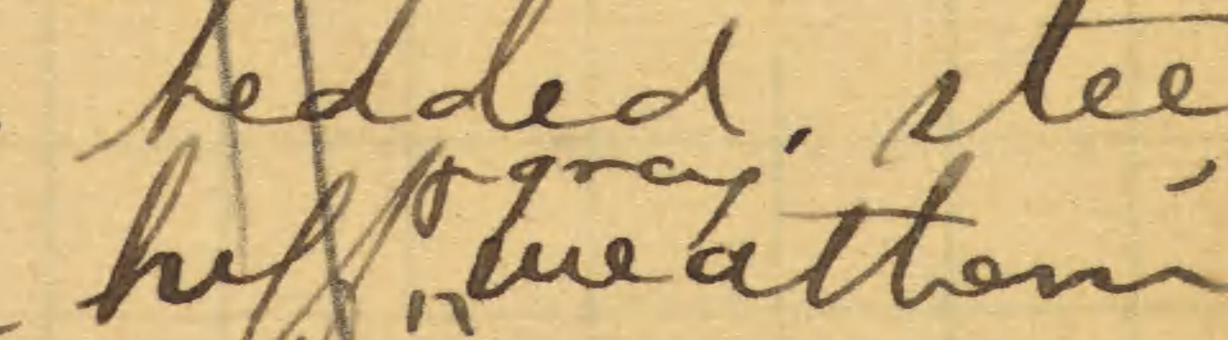
1E

Thin-bedded grey lm & s.d. with small lentiles of light gray lm. The irregular arenaceous portion weather buff forming a buff streak or band in ~~the~~ when the rock is in cliffs. 75

1F. Massive bedded, arenaceous - cliff forming lm. 675

Carboniferous.

2G. Thin bedded, steel grey - buff gray weathering lm. Fossils occur at 325 feet up. Spirifera noted



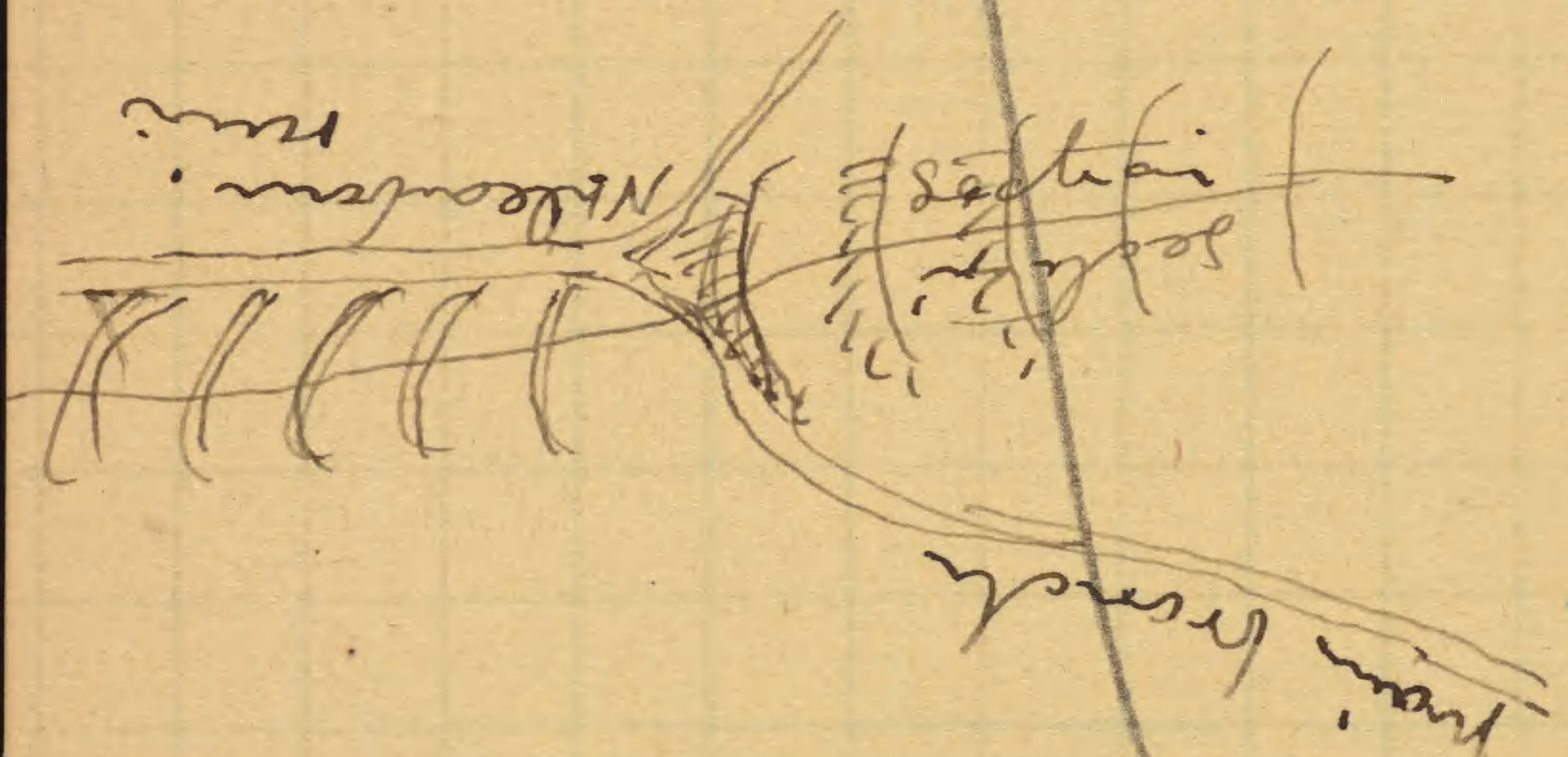
1380
725
425
1970

4500.
135

4635.

11 Dearborn

a thin bed of red & purplish-colored sandy shale occurs on the slope the trail passes over.



725.

2b) Massive bedded - dark gray - siliceous lim. breaking into angular fragments. At 155 feet a more shaly bed occurs -

2b

425
~~[illegible]~~
~~[illegible]~~

2c) Massive bedded light grey silicious lim. that ~~[illegible]~~ forms a strong cliff but breaks into small angular fragments.

2c

Noted Cyathophylloid

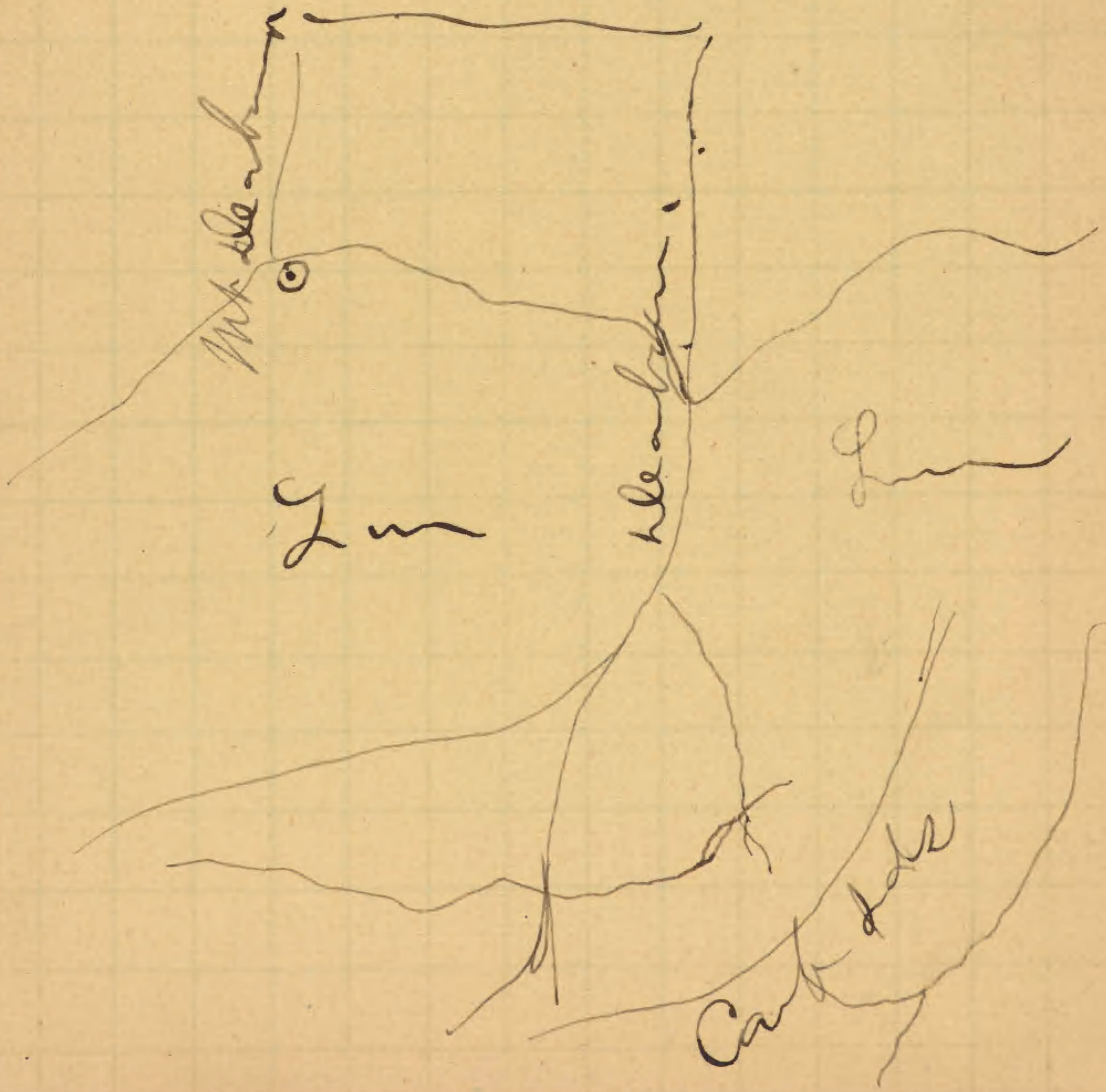
12 **Dearborn**

corals. Syringopora etc. 1970

3.

Brown thin bedded sandstone. 135

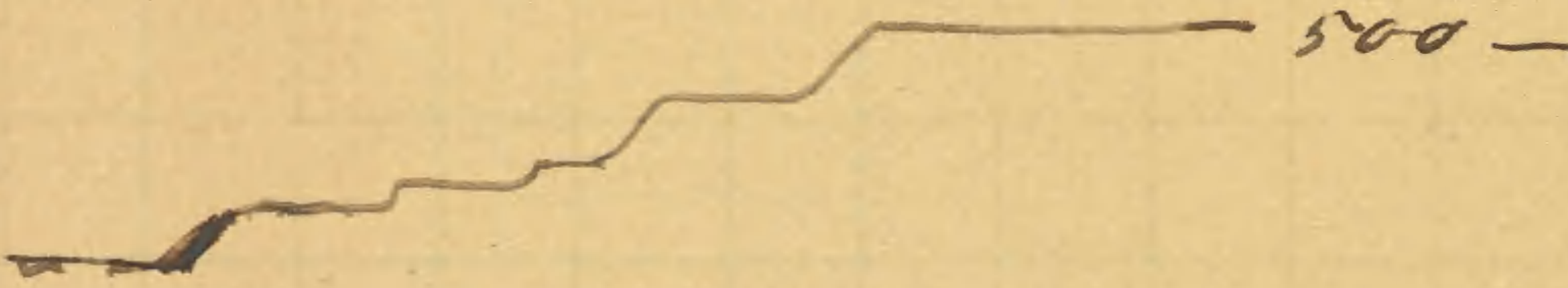
On the ridges to the south the sandstone are 2500 - 3000 feet.



Sept 5th 1900.

Terraces—

Clearwater above head of Salmon lake— East side. On road passing over ridge from Salmon to Fish lakes—



The outlet of the Clearwater below Salmon lake is thro' a canyon— This must have been closed in "glacial" time as these terraces rise fully 500 feet above the present flood plain of the Clearwater.

Notes & Glacial phenomena on Eastern front of Rocky Mts - Lewis & Clarke Cr. - Mants

Orogenic movements as indicated by eroded base level plains

South side Forest Reserve

July - Aug - 1900

C.L.W.

Glacial – Sun river –

On road from N. Fork Canyon to Willow Creek – lake, drumlins & eratics of lime & qtz occur. The eratics are often large & rest directly on the tops of terraces & hills just as they were dropped by the melting ice. Noted as far as 5 miles east of the mountain front.

Drift. (S. Fork Sun river)

Aug. 8/1900.

On high points N.W. of Haystack east of road White's mill to ranches west of Haystack the red rds, lm, etc of the mountains occur.

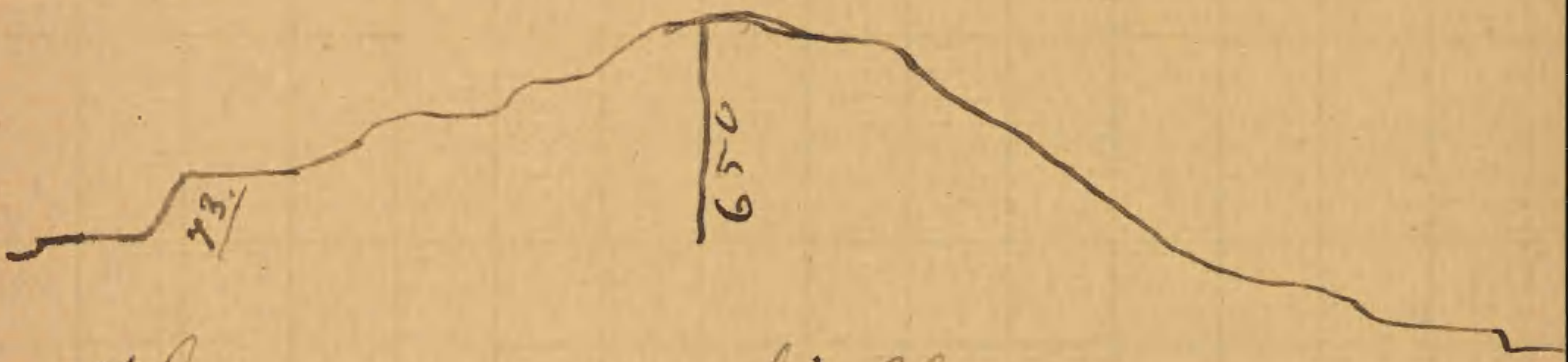
Glacial phenomena. 8-7-1900

Very few traces of glacial phenomena were observed along the eastern front of the Rocky Mts. At the North Fork of Sun River, Mont., a short distance below the mouth of the cañon, the presence of very large blocks of limestone arranged in north & south lines indicates a terminal moraine; also the presence of numerous small lakes on the ridges north & south of the cañon. These are found within a mile or two of the face of the cliffs. (And farther south were seen four or five miles from the cliffs)

The same phenomena are also observed at the outlet of the North Fork of Dearborn river, Mont. A block of siliceous limestone 25×15×5 occurs on the moraine 1½ miles from the cliff from which it was broken.

Terraces - Sept. 6/1900

Big Blackfoot Valley - 3 mi W. Ovando -



The gravel hills W. of Ovando rise 650 feet above Monture creek wh planes along their north & west sides. The hills are of glacial origin. Gravel & boulders of reddish sandstone etc derived from the rocks to the north of Monture canyon. They are great drumlins with terraces about their base

---

Ovando Hills.

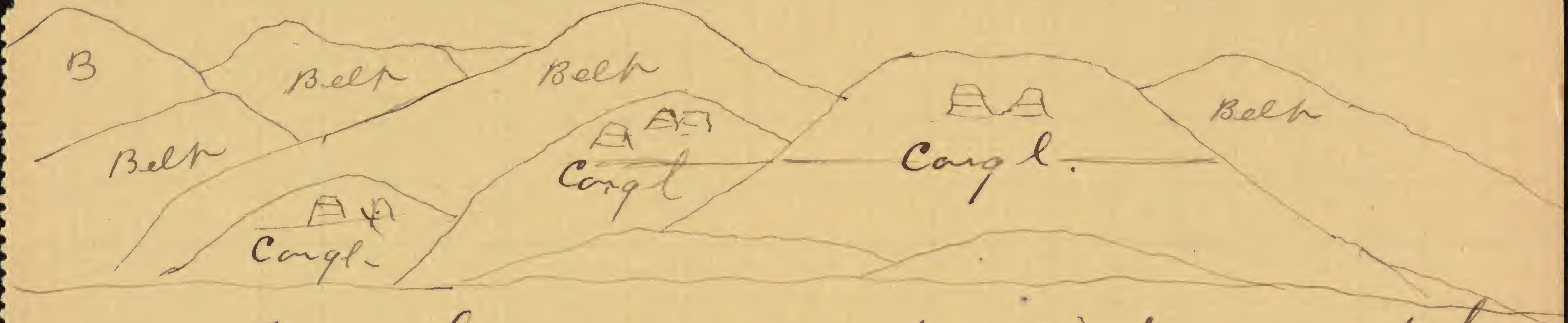
See Kodak views of the drumlins lakes etc. as seen from Ovando hills

---

The high level terrace about Ovando extends S. E. nearly to Helmville. Terraces occur E. of Helmville & along up Nevada Creek. S. E. of Washington Gulch P.O. on the divide between Nevada & Little Blackfoot creeks the terraces are very prominent 1200 feet above the level of the N. fork of the Big Blackfoot river at the road crossing between Ovando & Helmville. These high terraces may be remnants of the Tertiary deposits & a fragment of which -

occurs at the mouth of Monture canyon. The same high line of terrace extends up the Little Blackfoot valley as far as Elliston.

Crossing N. fork 4076.
" divide between Nevada creek & Little Blackfoot 5097.
Top of terrace 200 to 300 feet above divide



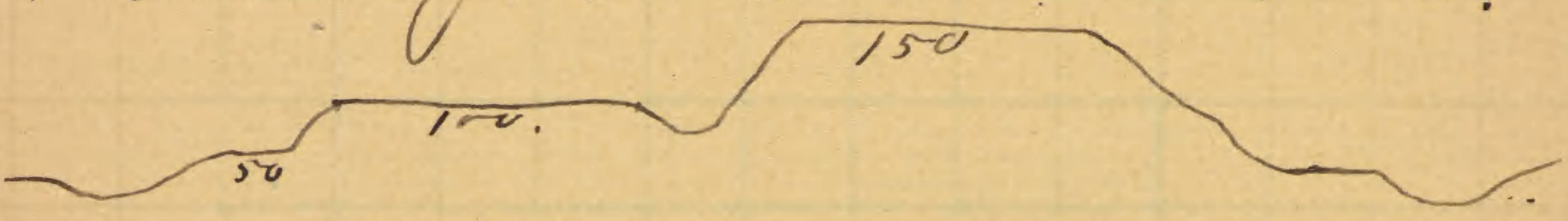
Congl — on east side north martin creek Canyon — Deerlodge Co. Mont

Aug. 29th

8-19-1900

Terraces -

N. branch S. fork Dearborn river.



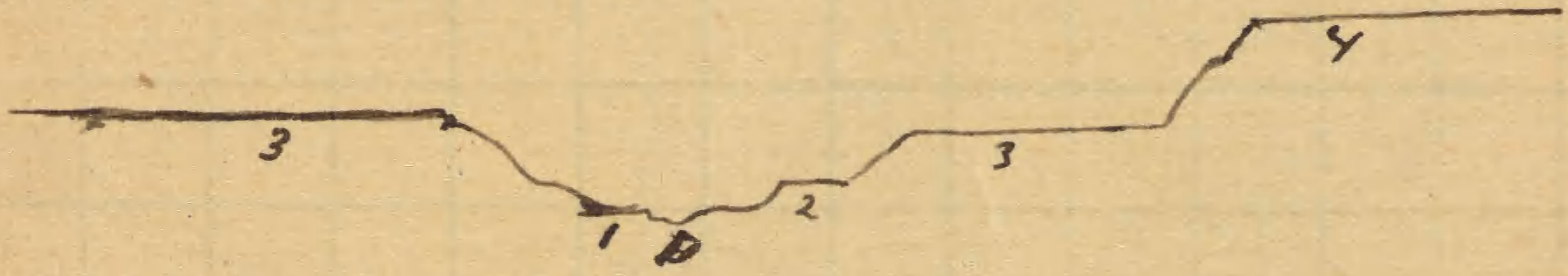
Section just below Steinbach & Alts ranch house - Crossing terraces & coulies -

The ~~150~~ upper terrace is 147 feet above the lowest terrace next to the stream bed - The 100 & 50 foot terraces are shown north of the ranch house - The 100 foot is very extensive & may be traced for miles to the east & north.

Aug 7th

Terraces. Deep Creek about 8 mi from base of mountains.

Slope 1° East of third terrace.



D = Channel of Deep creek
1 = Flood plain.
2 = Terrace about 30 ft up. from 1
3 = " " 100 " " " "
4 = " " 250 " " " "

The series of terraces represent.

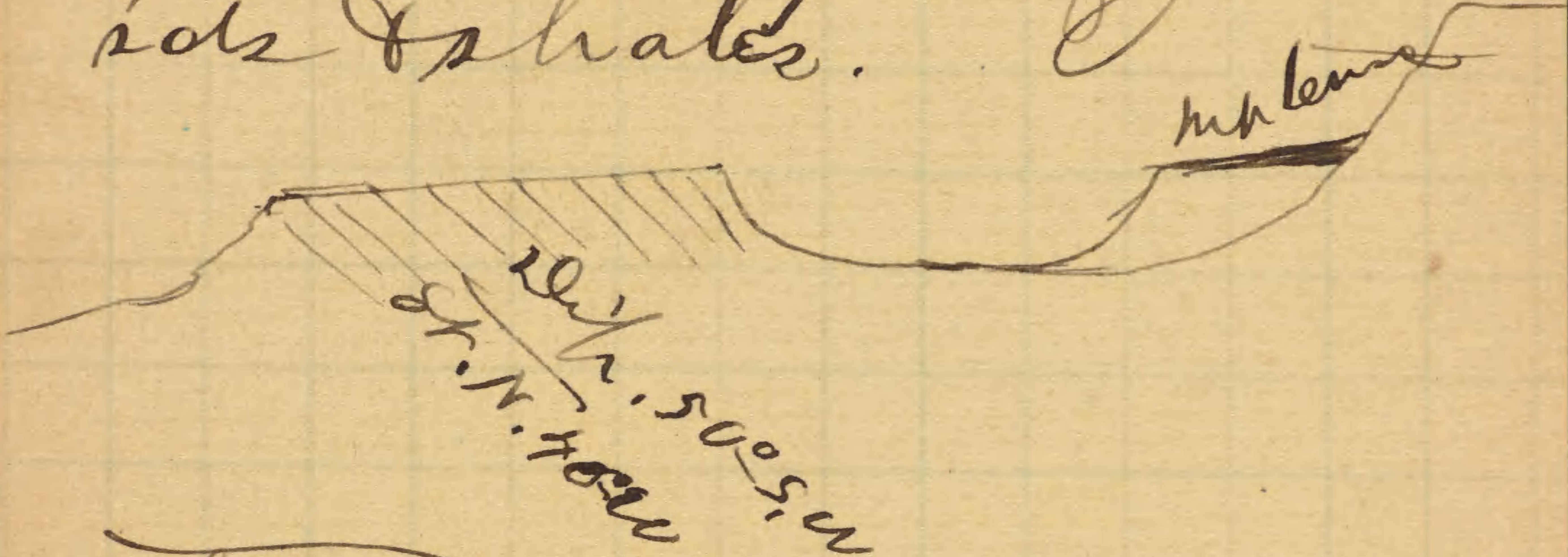
Nos - 3 & 4. base levels cut by subsequent elevation & resultant erosion.

No 2. Inner level within canyon result of ~~sudde~~ base level broken by ~~sudden~~ lowering of outlet of stream or raising of grade by uplift towards

the mountains. The last uplift is remote as the stream has cut its channel down nearly to base level & is now widening its. The 3d terrace is ~~cut~~ on graded in volcanic rocks a surface covering of ~~river~~ drift gravel ~~covering it~~ being spread over it. The drift gravels are of the same type as those in the stream bed at the base of the mountains - sds - qtz - lm. derived from the sedimentaries.

A fragment of the Tertiary peneplain is preserved E.S.E. of the mouth of Webb Creek Canyon. It rises three hundred feet or more

above the present plain between it & the mountain & slopes very gently to the east. The top is mantled with river drift & is planed off of the upturned edges of Jurassic? sds & shales.

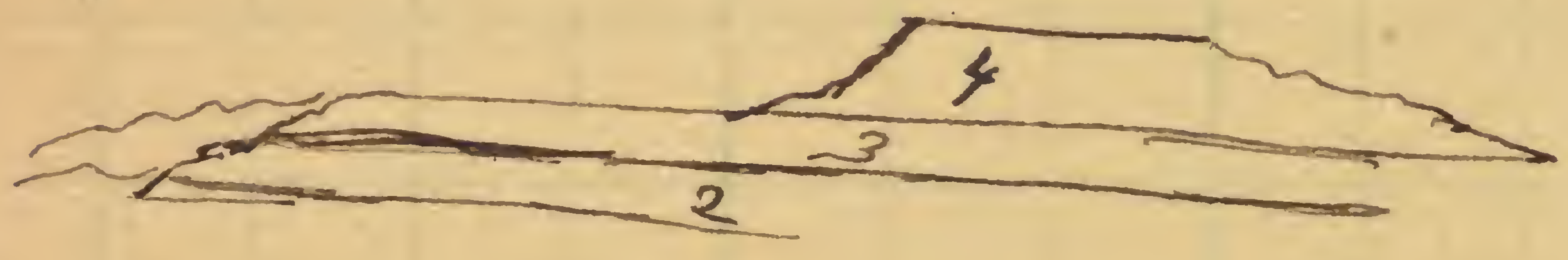


The butte is a ½ mile across N & S & nearly as much E & W. It appears to be a fragment of the pene-plain shown so well about 8 mi. S.E.

The mountain face shows a broad terrace at the same relative horizon 2-3 miles back from the butte.

The Canyon of Deep Creek has cut 600–800 feet ~~thro~~ down into the mountain bench or terrace – where it emerges from the range.

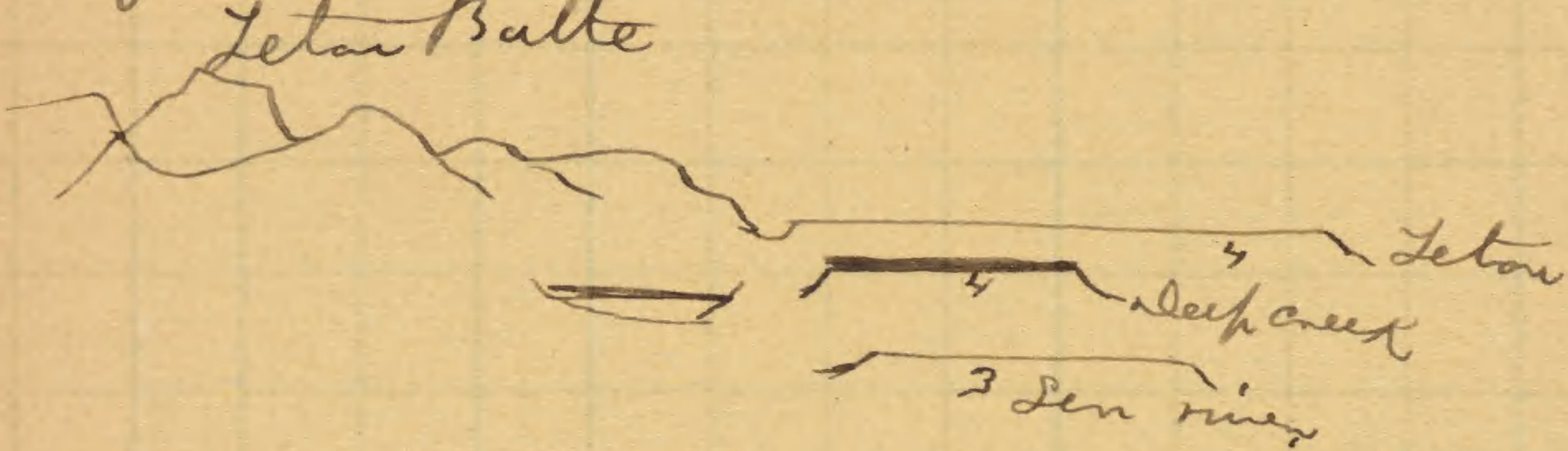
View from the south the butte & the terrace below is shown by photos 64–65.



The slope of No 3. is 1° 7 to 8m' from the mountains & 2° about a mile distant from Mts.

Aug. 13th 1900.

From Haystack Butte the terraces of the N. Fork Sun river & Deep Creek are beautifully shown. They can be traced by the eye east beyond Augusta. The high level (4) is also well shown east of Teton Butte



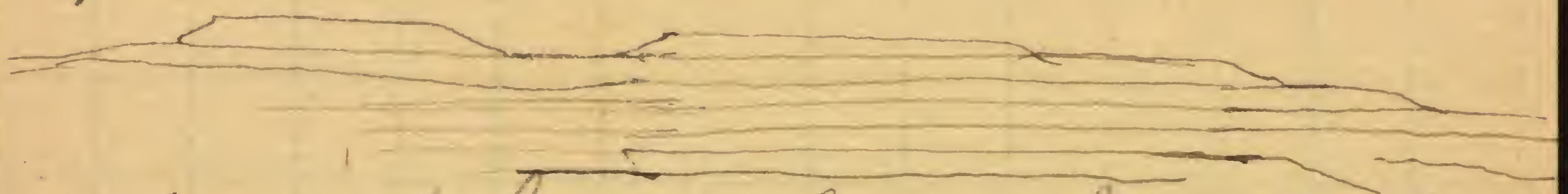
Glacial lakes are scattered very widely for two to four miles out from the Mts.

Glaciers appear to have covered much of the front from Dearborn river drainage north to Teton drainage / Did not go north of latter.

On north side S. Fork Sun river as seen from Elk creek six terraces are outline between ~~creek~~ stream bed &

top of 6

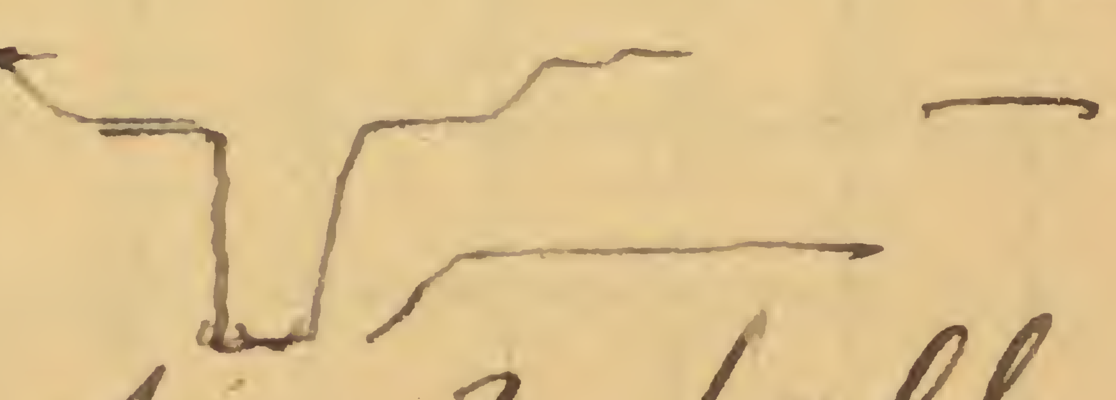
p terrace (Tertiary Pene plane.



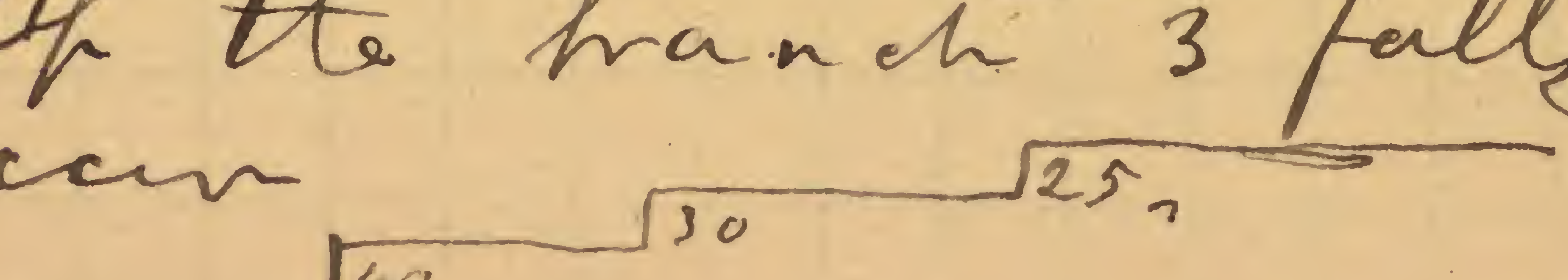
Took photo but the distance & haze probably dimmed the outlines of the terrace wh. showed finely in the late afternoon sunlight.

Dearborn.

At the mouth of the south branch of the N. Fork of the Dearborn, the branch has cut a canyon 100 or more feet deep in the solid siliceous beds of the Belt (Empire?) & on the slopes above the canyon the old terrace lines are shown



Up the branch 3 falls occur



& 3 miles up a low fall -

On the main river a falls occur about 3½ miles up from the south branch - about 25 feet.

From the N. fork of the Dearborn river south there is one very clearly defined terrace ~~that has~~ been deeply cut by Conniffs creek & the various minor drainage lines between Conniffs creek & the south fork of the Dearborn river.

Between some of the streams the ~~pl~~ plain is unbroken for several miles. The county road from Stearns P.O. west is situated on this (terrace) plain for several miles after it rises from the Little valley out in the plain by the S. fork of the Dearborn. crossing a broken down place it extends on the plain to the base of the mountains.

Resumé. From the few incomplete observations made I am lead to conclude (a) That in late Tertiary time the rivers + streams flowing eastward out of the range had then ~~nearly~~ have leveled the area lying east of the mountains.

(b) That an uplift of the range followed and a plain formed at an horizon approximately 200 feet lower

(c) that a second uplift occurred that caused a deepening of the stream beds + the removal of much of the former plains. Another plain was formed + later several minor plains + subsequent terraces

The successive plains & uplifts are as follows -

Tertiary? ———		250, above Deep Creek
Pleistocene	No 3.	100.
"	" 2	30.
"	" 1	6. =

= Present Flood plain at very high water.

South from Deep Creek the terraces are less elevated & fewer in number until on the branches of the south fork of Dearborn there is but one upper plain indicated - This is extensive & appears to correspond with No. 3. Within the valleys cut in it several minor plains are indicated by terraces.

The decrease in elevation of the terraces to the south of Deep Creek indicates that the uplift was greater to the north ~~and~~ the record of the successive changes of level is also more complete.

The present level appears to have continued from the "Glacial Period" as glacial lakes & erratics are on the lower terraces as well as on the higher levels.

The canyon of the south branch of the north fork of the Dearborn river is cut thro' the terraces within the broad main canyon but there is little evidence that the rock cutting was prior to the deposition of the terrace material. On the contrary the terraces are usually fragments of plains (base levels) formed by the erosion of the underlying rocks - This is finely shown in nearly all the terraces.

Belt. Oct 10" /98

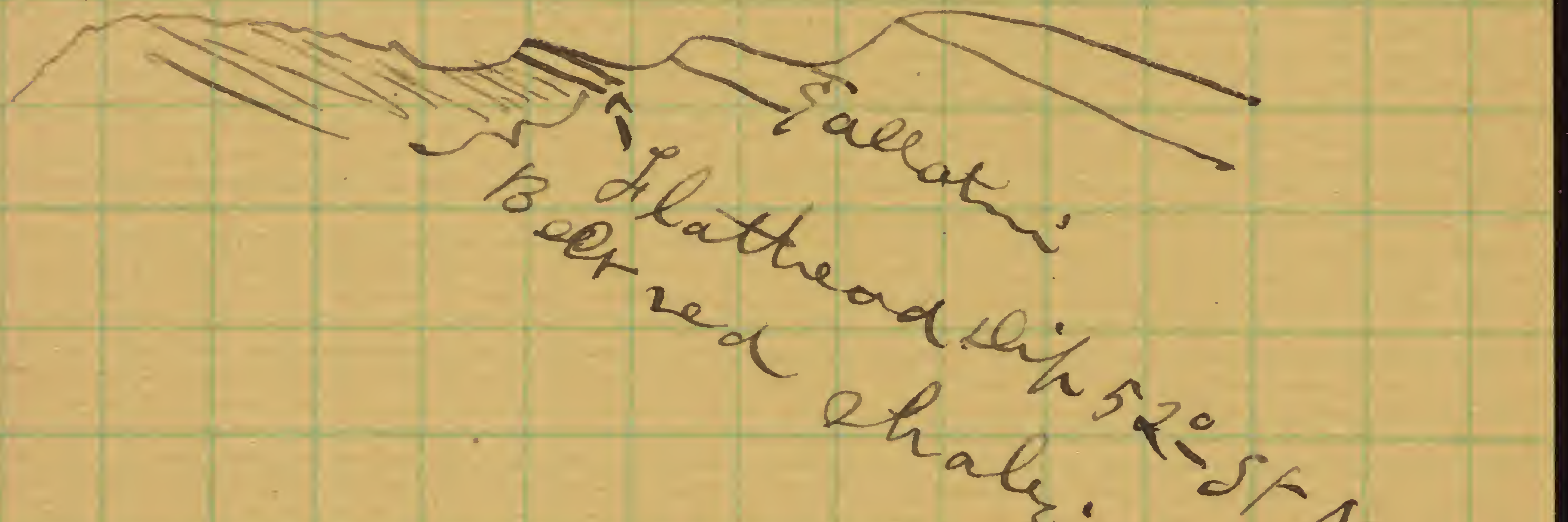
Deep Creek & Greyson canyon East of Townsend. Mont.

The Deep Creek section has been noted. Crossed from mouth of Canyon on Deep Creek across to Greyson Creek Canyon. A fine section of the sand & buff & red shales is exposed up to the contact with the Flathead qtz (Cambrian). The lower portion of the Flathead is lighter than the upper part which contains many streaks of reddish-brown sd - as tho' it was derived from the red Belt shales beneath.

Flathead dips about 50° north.

Oct 11th/98

Ten (10) miles north of Townsend on foot hills of S-end of Boulder range - north of road to Radersburgh.



Same Belt series as at Greyson canyon - sdy - grey + greenish beds with bands of hard qtzitic sd - Red beds above with beds of qtzt - sd - The basal bed of the Flathead contains qtz pebbles up to 3/8 in, & pebbles of the Belt green, red & drab shales +

At the mouth of Prickly Pear canyon – about 2 mi south of East Helena the Flathead (Cambrian) qtz sd – rests on a band of drab sdy shale about 15 feet thick – Dip 30° W. st. N & S – Beneath this shale the Helena limestone extends downward for a thousand feet or more. ~~abou~~ It is about the same character as at Helena –

Out on the slopes S.S.E. of Helena the

red & green sandy &
argil - shales outcrop
from beneath the Helena
lime - series -

Sept 22/98

Belt Terrane
Up Saw Mill Canyon
from Neihart Montana

Gneiss.

1) Massive, sometimes cross-bedded, quartzite sandstone. Gray & coarse below & occasionally a fine conglomerate.
Rough estimate 700.

2. Reddish coarse sd passing above into shales - dark, greenish with layers of fine grained sandstone.
Dip 15° S. 30° ~~W~~ East.
St N. 40° E.
Rough Est. 300.

3. Dark siliceous & sandy shales
R— est. 1500

Belt 2

4). Impure dark limestones weathering to buff colour - Many partings & bands of siliceous & calcareous shale.
R — est. 500.-

5). Siliceous & argillaceous shales with occasional beds of impure limestone.
R. Est. 1000.
Fossils at 100 feet in sh (200)

6) Purple & reddish brown shales passing above in coarse massive sandstone - St. N. 30° E. Dip 15° S. E.
R — est. 500.

7.) Interbedded eruptive.
R — est 200.

8) Dark siliceous shales
— Concealed
4700

Cambrian.

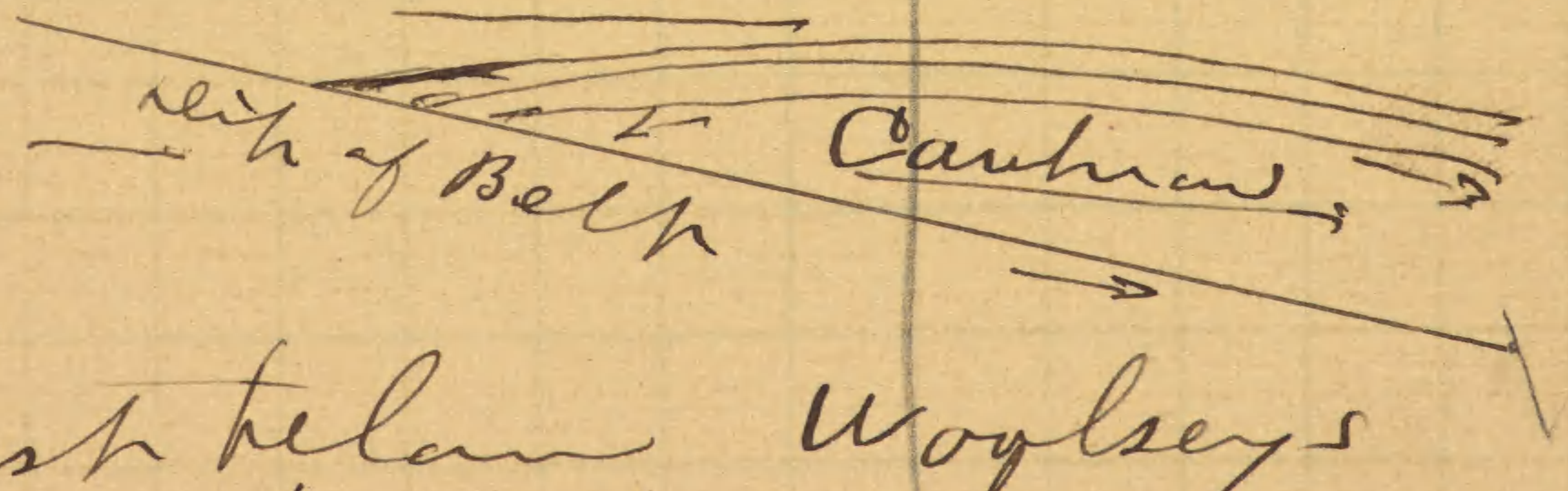
Belt – section 3.

Cambrian – Light gray, fine grained quartzitic sandstone with Scolithus borings.

Near site of lower sawmill the strike of the Cambrian beds is E & W – Dip 10° North.

The red sds of the Belt have a strike of N. 30° E. Dip 15° S. E.

Above the saw mill 1/2 mi the Cambrian sds are horizontal & a little further on the strike is E & W – dip is 3 to 5° south

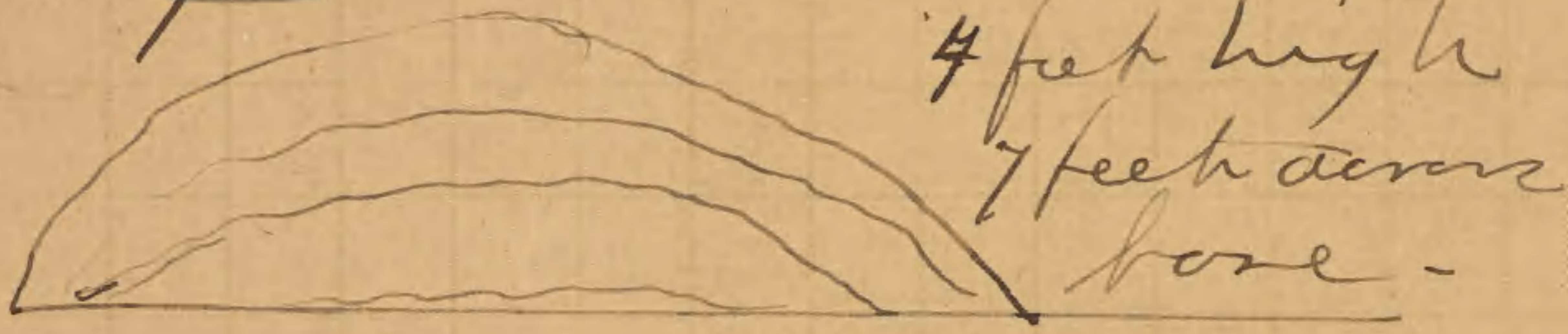


Just below Woolseys ranch noted fragments of the sdy Belt shales in the light gray quartzitic sandstone of the Cambrian in a layer 30 to 50 feet above the base of the Cambrian —

The Cambrian rock, is a sand of transgression — washed clean by the sea advancing on the land — Not a sand of river & tidal deposition mixed with muds — such as the upper red sandstone of the Belt terrane.

July 18/05

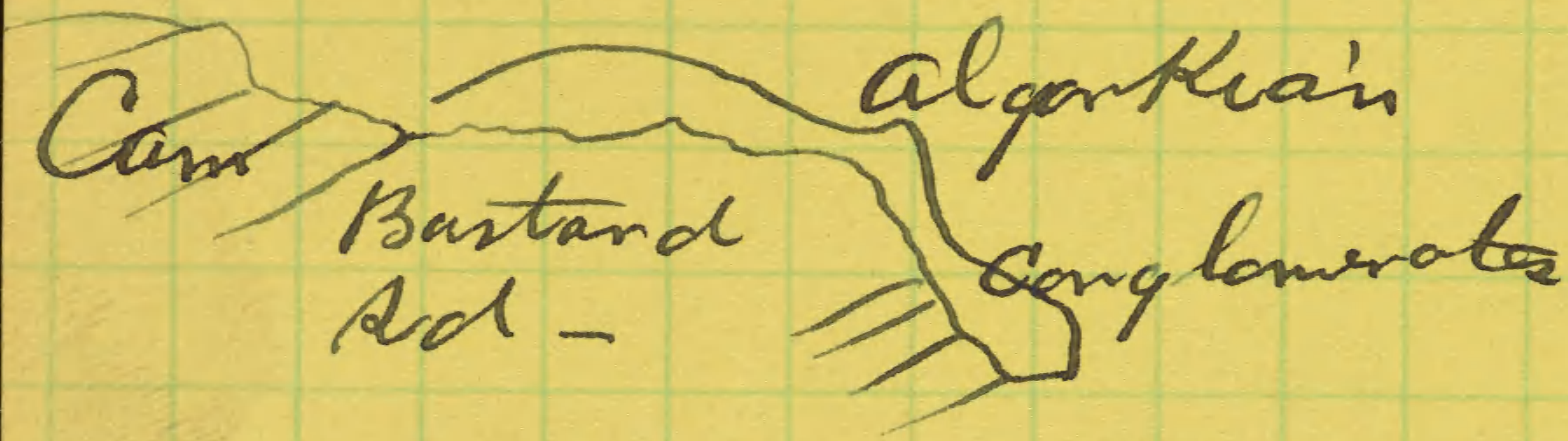
Crytozoon.



On the east side of Big Prairie - South of Baker Creek the Algonkian limestone (Holland) shows beneath the red beds (Blackfoot) with a thickness of 1500 feet or more. The terrane has the same general features that it has at Holland Peak in the Swan range - Limestones & silicious cherty beds alternating in an irregular manner. About 300 feet below the red beds a band of grey lime about 75 feet in thickness occurs in whi

Algonkian

Jefferson Canyon.



Conglomerate contains limestone boulders up to 2 feet in diameter. No siliceous, arenaceous

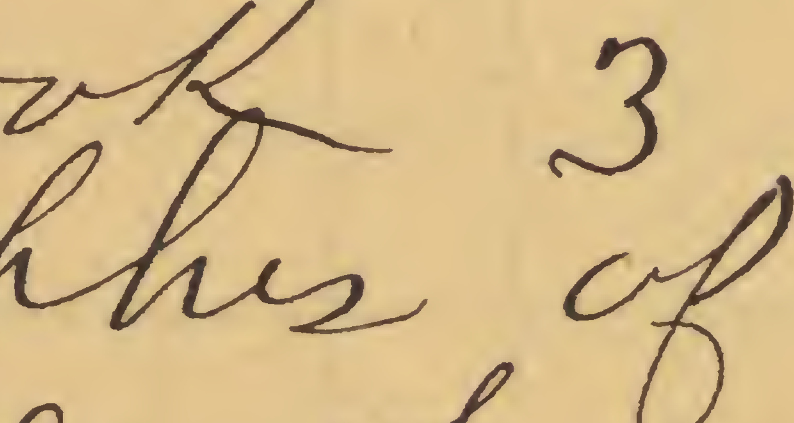
traces of fossils

Sept 14/98

Rock Jointing.

Belt - siliceous beds - Deep Creek Canyon about a mile above Glendinnin's house on road Townsend to White Sulphur Spgs, Mont.

Took 3 photographs of west face of beds that dip ~~west~~ 70° to the west. A fine illustration of jointing & fracture.



Sept 14/98

Interformational conglomerate. Belt Terrane - Deep creek canyon above Glendinnin's on road Townsend to White Sulphur Spgs. Mont.

a fine illustration see photographs

Oct. 7/98.

Belt -

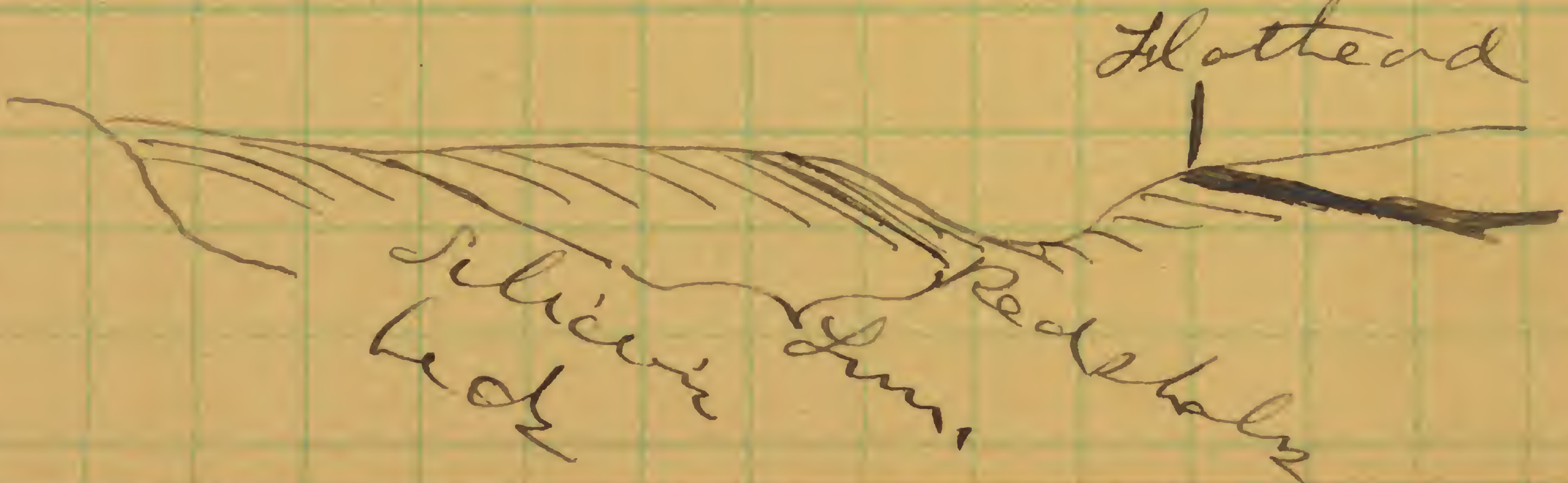
Helena to Marysville
Mont.

The western outcrop of the Belt rocks extends N.W. of Helena passing about 8 mi west of Marysville (see map based on L.S. Griswolds ~~map~~). The Helena limestone outcrops all along the hills & gulches & extends eastward to the bottom lands of Silver Creek and northward ~~into~~ & across the valley of Little Prickly Pear Creek. At Marysville a granite dome has pushed the limestone & the banded silicious beds up & back. Just east of Marysville the Northern

Pacific R.R. - Cut passes thro' a thick mass of the silicious beds - Banded light & dark grey rock that breaks into the slaty ~~th~~ and shaly layers on exposure to the weather. Probably 600 feet in thickness exposed -

West of the Marysville granite area the dip of the silicious beds is low - 10° 15° N.W. and about 200 feet of ~~quite~~ quite pure limestone are interbedded & some the rock series is more calcareous than silicious - On the spur between Lost Horse & Little Prickley Pear gulches the dip increases to the westward & ab the west end of the ridge a band of reddish-sandy shales appear dipping N.W. at 35°. Limestone comes on top of them & then buff calcareous followed by red sandy shales. On the slopes to the west of Lost Horse gulch. The Cambrian Flathead sandstones are almost invariably concealed by debris their position being indicated by boulders of gray & reddish quartzitic sds. on the Hill slopes.

Section



4

Flathead — Cambrian.

a. Reddish sdy shaly beds	50
b. shaly limestone	250
c. Red sdy shales —	100.
d. Limestones	600
e. Light & dark grey siliceous, banded beds Est.	500.

Section broken by granite.

Algonkian Section

July 6/05

Ovando quadrangle.

West slope Trapp Mt. on East side of Camp Creek.

1) About 100 feet of compact arenaceous + oolitic) grey thin-bedded limestone and dove colored probably the Helena limestone of the Belt Mt section.

The following is the section of the ~~reddish~~ sandstones resting on the limestone. (~~see p. 1 a~~ Over

2.

a) Chocolate red thin bedded sandstones alternating with gray arenaceous limestones. (dip 25° N. St. N. 80° E).

At 370 feet up Cryptozoon

The limestone will be measured on the Swan range. 25 west & on the north fork of the Blackfoot river to the south.

560
47.
70
350
47
397
85
140
550.
73
623
880
73
15
75
85
160
110
224
19
28
140
19
150.
33
17.
5
85.
11
96
136
11.
133
5
665
88.8
753
1064
96
88.
104
400
75
5
375
50
35

is abundant in
a ~~thin~~ layer about 6 in
thick
dip at summit 40° 395

b) Grey sandstone, thin 72°
bedded & shaly with
small wave & ripple marks &
mud cracks. dip. 40° 85.

c. Reddish brown sds.
thin bedded - often 76°
shaly -
dip gradually increases
to ~~6~~0° to 70° 623.

d) Grey sds. similar to 73°
b. 158.

E. Reddish brown sds 30°
similar to c. 753

f. Gray - shaly & thin
bedded hard sds.
at 96 feet up a bed 70°
of Cryptozoan occurs in
a rough grey sd - about
4 feet thick 425 239a

55

$$\begin{array}{r} 35 \\ 5 \\ \hline 175 \\ 23 \\ \hline 198 \end{array} \qquad \frac{280}{23}$$

110

$$\begin{array}{r} 85 \\ 5 \\ \hline 425. \\ 57 \\ \hline 482 \end{array} \qquad \frac{680}{58}$$

$$110 \qquad \frac{880}{7.3.}$$

$$\begin{array}{r} 550 \\ 73 \\ \hline 523 \end{array}$$

300.

3 2439

g Reddish brown sds -
Thin bedded & shaly -
at 52 - feet ob. a
band of Cryptozoon
occurs - 68,

h. Grey sds & shales -
shales predominating 48 2,

3)
k. Compact grey lime -
thin bedded & shaly -
siliceous texture occurs - 198,
b weathers buff in many
layers.

345

4) a
1. Hard, compact ~~sds~~
grey sds - almost quartz-
itic in the thickest
layers - a
b at 340 - Light grey sdy
shales - in places a little
calcareous occur. for
about 30 feet - above

48
5

240.
32

272
523

766,

(384

32,

thin bedded sds &
shales alternate with
an occasional qtzitic
sd - layer 8 in to 10 in
thick. ——— 700.

523

This grey sd - band
also found to are
conspicuous features in
the ridges - as the color
shows in strong contrast
with the rich reddish
brown bands -
Ripple - marks & mud
cracks occur frequently.

388

4 b)
~~K. Reddish brown sds -~~
~~thin bedded & shaly -~~
~~similar to c -~~

at - 523. feet a reddish
band about 15 feet thick
occurs & then an alternation
of shaly ~~sds~~ & thin
bd sds

53
160
5
800.
103
907.

142

88
264.
5
1320
176
1496.

250
160.
90

450.
60
510

13
42
5
210
29
239

262.
5

63
190
5
950.
127

247. 1077

264
160
104.

78.
8
~~14~~
70.

50
250.
32
284

4h . 5

~~IV~~. Cont'd ~~4487~~ 3887

at 910 feet the shall & thin bedded layers ~~become~~ less prominent & layers of a grayish red sd. 3in to 2 ft thick abound alternate with shaly bands & parting g.

1 - Thin bedded & shs. 910.
2. Thicker bedded. 510.
3. Thin bedded & sh. 76.
1496.

Thin bedded reddish -
76 -

Ripple marks & mud cracks very abundant near summit. 1496
5383

~~4~~ 5)
~~V~~. Green & reddish shales - passing ~~about~~ 60 feet up into alternating thin bedded reddish sds & shales - the shales gradually ~~[illegible] &~~ give way to thin bedded

44
134
5
670.
90
760.

37^2 — 3
5
185
25
210.

117,
9
~~36~~
~~108.~~
540
72
612

45.
6
51

6

5383.

reddish sds - at 1077 ft which continue up. 285 ft - 1362

6^a

~~m.~~ Coarse grained more or less cross bedded reddish grey sd - in layers 2 in to 14 in thick, becoming quartzite sd above 50 feet. Toward the upper part in the reddish color the softer & thinner bedded sandstones predominate 970

6 b

~~N.~~ Reddish shaly sds - 51

6 c

Z Green sandy shales with thin layers of greenish grey compact sandstone occurring irregularly in sh. 612

8378

Dip 75° N. St. N. 70. E.

300.
5

~~1500.~~

1 0 7
3 2 2
5

1 6 1 0
2 1 5

1 8 1 5.

8978.
1560
1762

12300.

7 8378

6d D. Reddish brown, arenaceous shales & thin bedded sds — alternating irregularly with
202 greenish grey bands of shales & sds. Some of the thicker layers — 2 in to 6 in are somewhat quartzitic — 1560.

At this point the section was taken up on the west side of Camp Creek / or rather at its head / as ~~the~~ ~~the was~~ west ridge was not covered with forest. The section has been very clear & well exposed up to this point.

7./ Compact hard grey, sds — almost quartzitic in many layers.
8 Layers vary in thickness 1/4 in to 10 in Often marked by ripples & mud cracks. 1762

near 75° N. at base 70° N. at 700 feet up increasing to 80° at 1200 - & continuing high up to contact at summit with the fine conglomerate at the base of the Cambrian sandstone. The latter has a high dip north & is apparently conformable with the upper beds of the Algonkian. The conglomerate is overlain by thin bedded sandstone & these by the Woolsey shale & above the latter cliff forming thin bedded Cambrian limestones.

9

Camp Creek section

1. Limestone	100	100+
2.(a) Red beds + lm. –		395.✓
b. Grey sdstone		85.✓
c Red " " .		623.✓
d. Grey "		158✓
e. Red " (like c)	5/	763✓
f. Grey "		425.✓
g Red "		68✓
h. Grey "	2999	482.✓
3. Compact grey lm.	198	198✓
4. a Grey sds,		700✓
b Red " .	2196	1496✓
~~c~~		
5. Shales, green & reddish		1362✓
6. a Red sds		970✓
6. b. ~~Red~~ shaley sds		51✓
6 c Greenish sds & sh		612.✓
6 d Red sds	4555	1560✓
7. Grey sds	1762.	1762
	11710	

arenaceous sediments mainly.

Numerous localities

Sept 30/98

Belt —

Helena, Mont.

Section from 1/4 m. S. of Broadwater Natatorium S. to the Flathead quartzite capping the point North from Mount Helena —

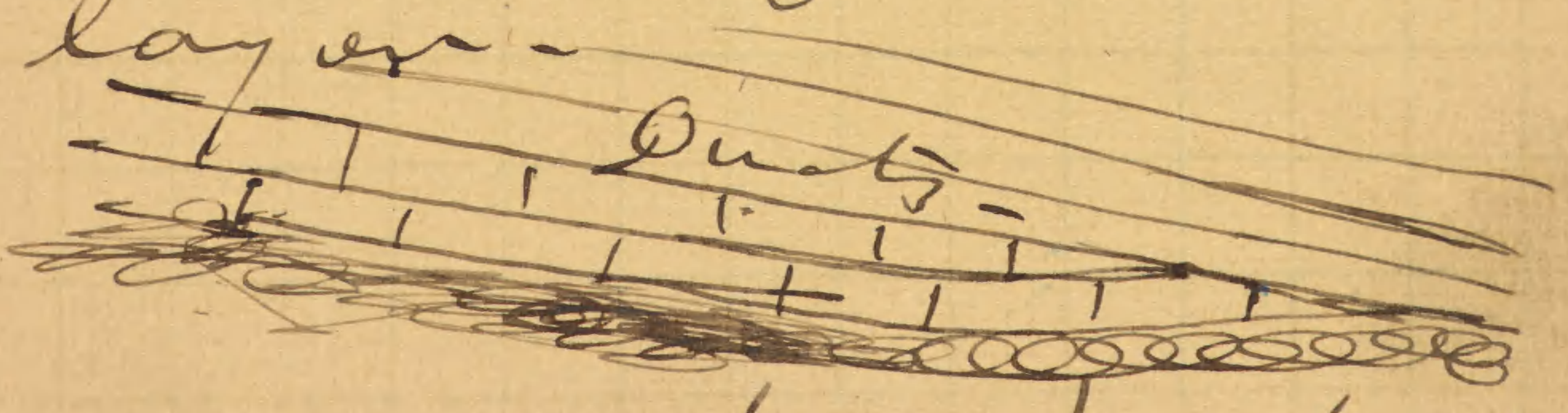
a more or less impure limestones in thick layers. Weathers buff & some layers bluish gray — Irregular bands of brecciated, oolitic — and concretionary limestone occur at various horizons — At about 1000 feet up in the section more ~~are~~ arenaceous shaly beds appear & the limestone is in thinner layers. This continues up to within about 75 feet of the Flathead quartzite where

arenaceous - silicious + argillaceous purple + dark shales appear.

This section brings the upper limestone series to within 75 feet of the base of the Middle Cambrian. ~~Virtually there is a thousand feet or more of the shale beds between the Flathead qtz & the Belt limestone~~

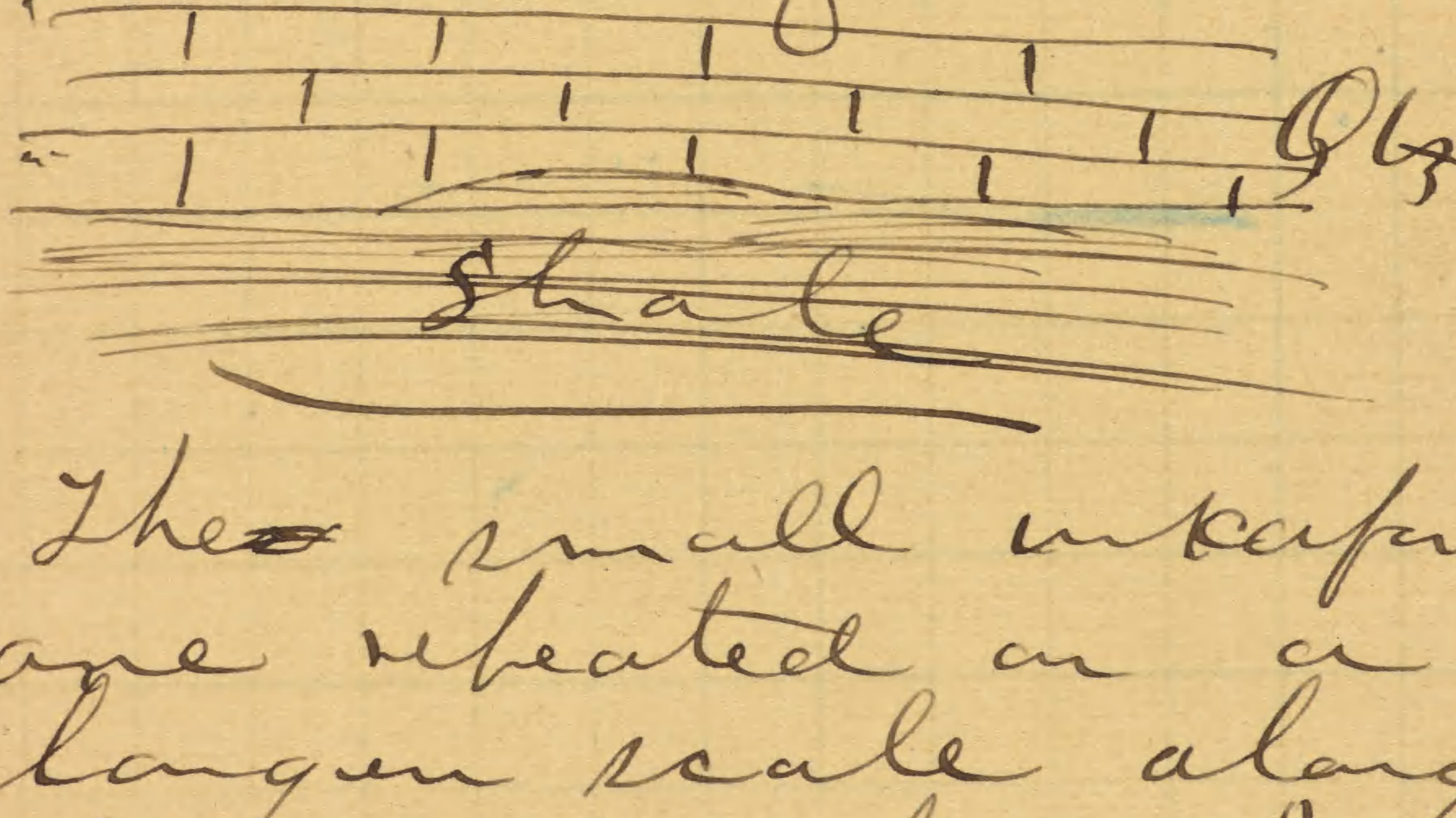
P. M.

Crossed to the east side of Helena & followed the outcrop of the Flathead quartzite. The upper massive-bedded limestones of the Belt are fully 250 below the quartzite on the west side of the town the interval being filled by sandy & argillaceous buff & purple shales. A half mile to the east the limestone is not more than 20 feet below, and in a prospect cut south of the suburb Lenox the quartzite rests directly on the limestone. At the line of contact there is a slight unconformity in a distance of ten feet the upper surface of the limestone is eroded ~~cut~~ so as to cut out 18 inches of the upper layer.

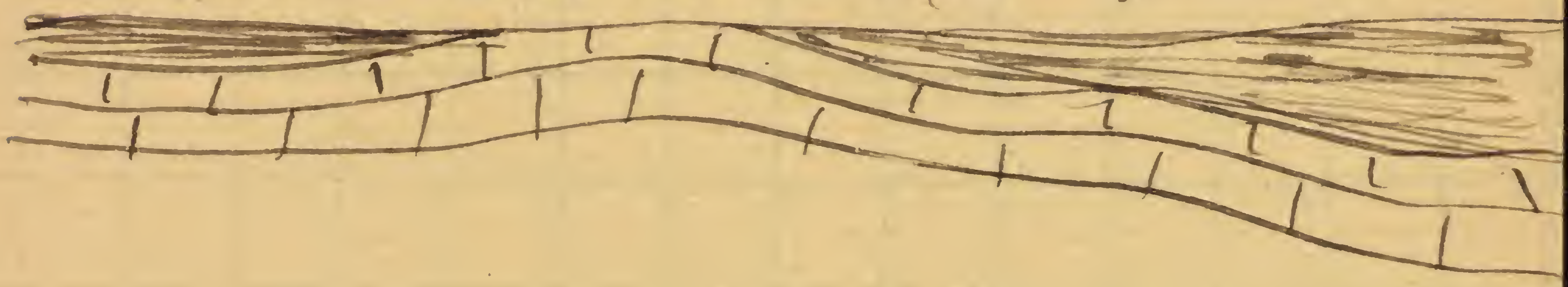


At another prospect

cut about a mile to the eastward a band of argillaceous shale caps the limestone & the quartzite rests on the shale. The only evidence of non-conformity is small ~~boss~~ mass of shale rising up from the general level of the summits of the shale.



These small unconformities are repeated on a larger scale along the strike by the increase in the thickness of the shale, & the cutting down to the limestone of the upper surface of the Belt;



Oct. 3d/98

15 mi N. of Helena - The section shows - Greenish - reddish-purple & bands of dark shaly-slates & layers silicious & argillaceous. Near Hilgar's ranch house the Flathead qtz occurs in broken masses above the Belt beds - The section of Belt is thick, probably 1000 feet or more but it does not reach

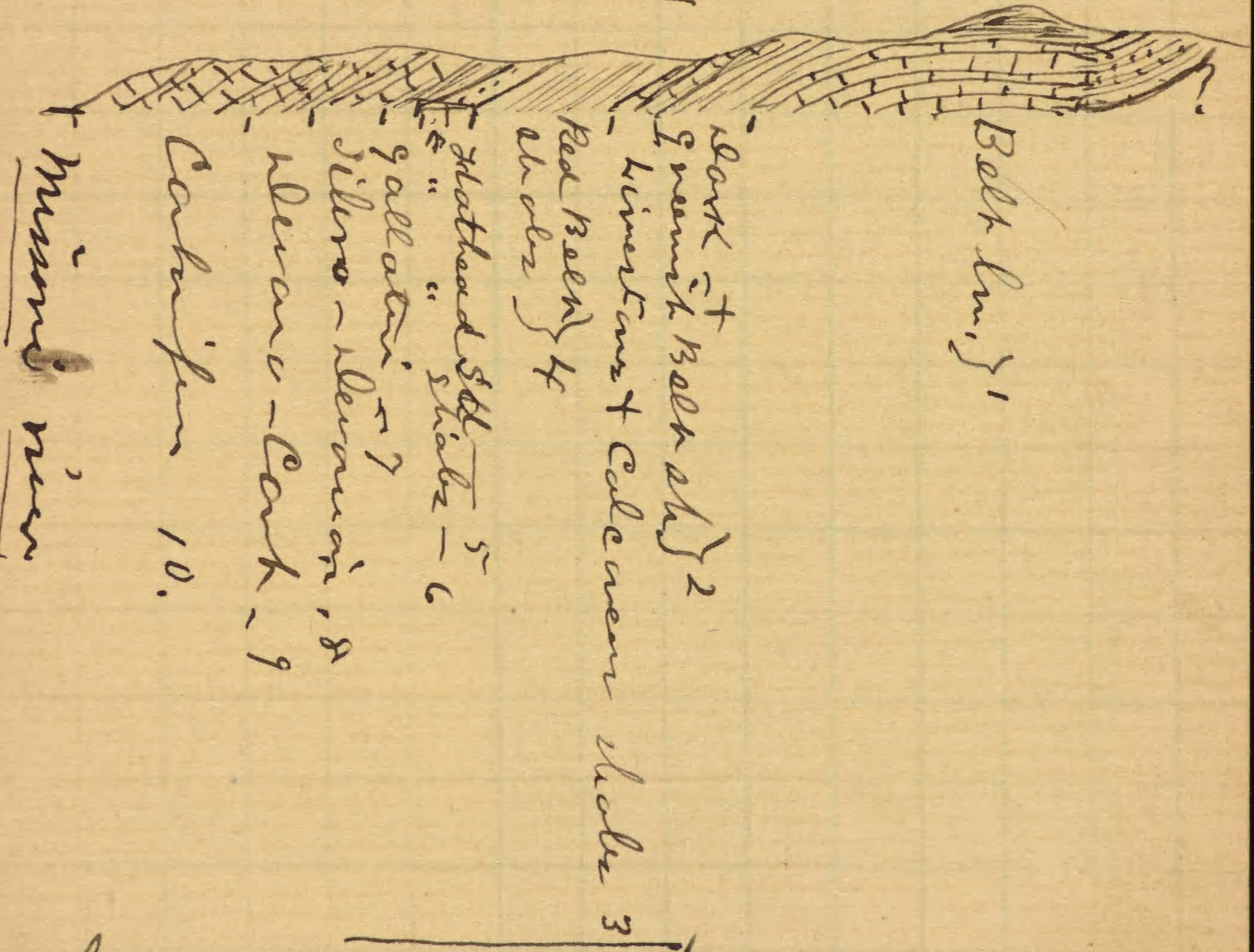
6

~~down~~ up to the upper limestone of the Belt series as at Helena

Oct. 4th 98

Belt & Cambrian.
See section of 1900.

Section on Beaver Creek East side Missouri river — 20 mi N.E. of Helena Mont.



The Belt shows a limestone series ~~at~~ (1)

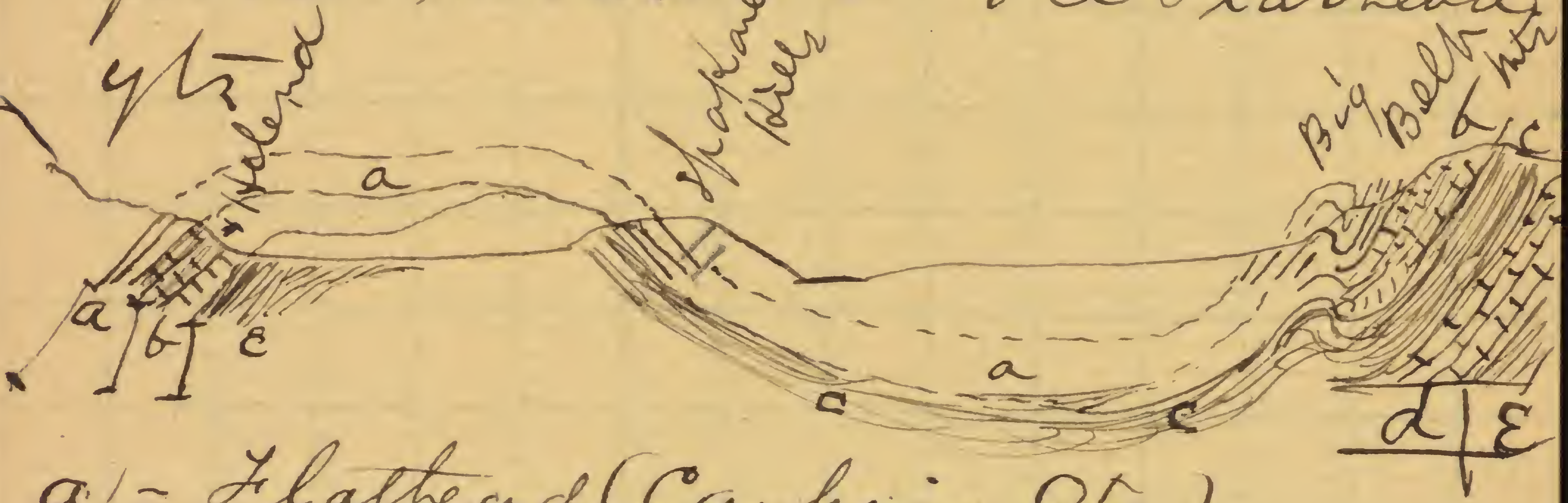
beneath the more or less calcareous shales. A thin bed of lim-(3) and a thick mass of reddish & greenish sandy, siliceous & argillaceous shales -(4) then one (2) two to (3) three thousand feet thick between the limestone (1) and the Flathead qtz (5). The upper limestone of Helena is absent either by erosion or non-deposition.

The red shales (4) are about 1000 feet thick. On Trout Creek below York the Red shales are in contact with the Flathead - Apparently conformable -

8

Oct. 5th

Crossing the Spokane Hills to Canyon Ferry from the west the red Belt shales dip west & pass beneath the Flathead qtz



a) = Flathead (Cambrian Qtz)

b) = Belt limestone upper band (Helena) limestone)

c) = Red Belt shales—beneath b. (~~Spokane~~ Greyson)

d. Lower Belt limestone—(Newland)—Not seen ~~near~~ Helena.

E. Dark silicious shales—(~~Deep Creek~~).

The Helena limestone of

the Belt is absent in the Spokane Hills section just as at the Gate of the Mts, Beaver Creek. Trout-Creek - + at Deep Creek 20 miles south -

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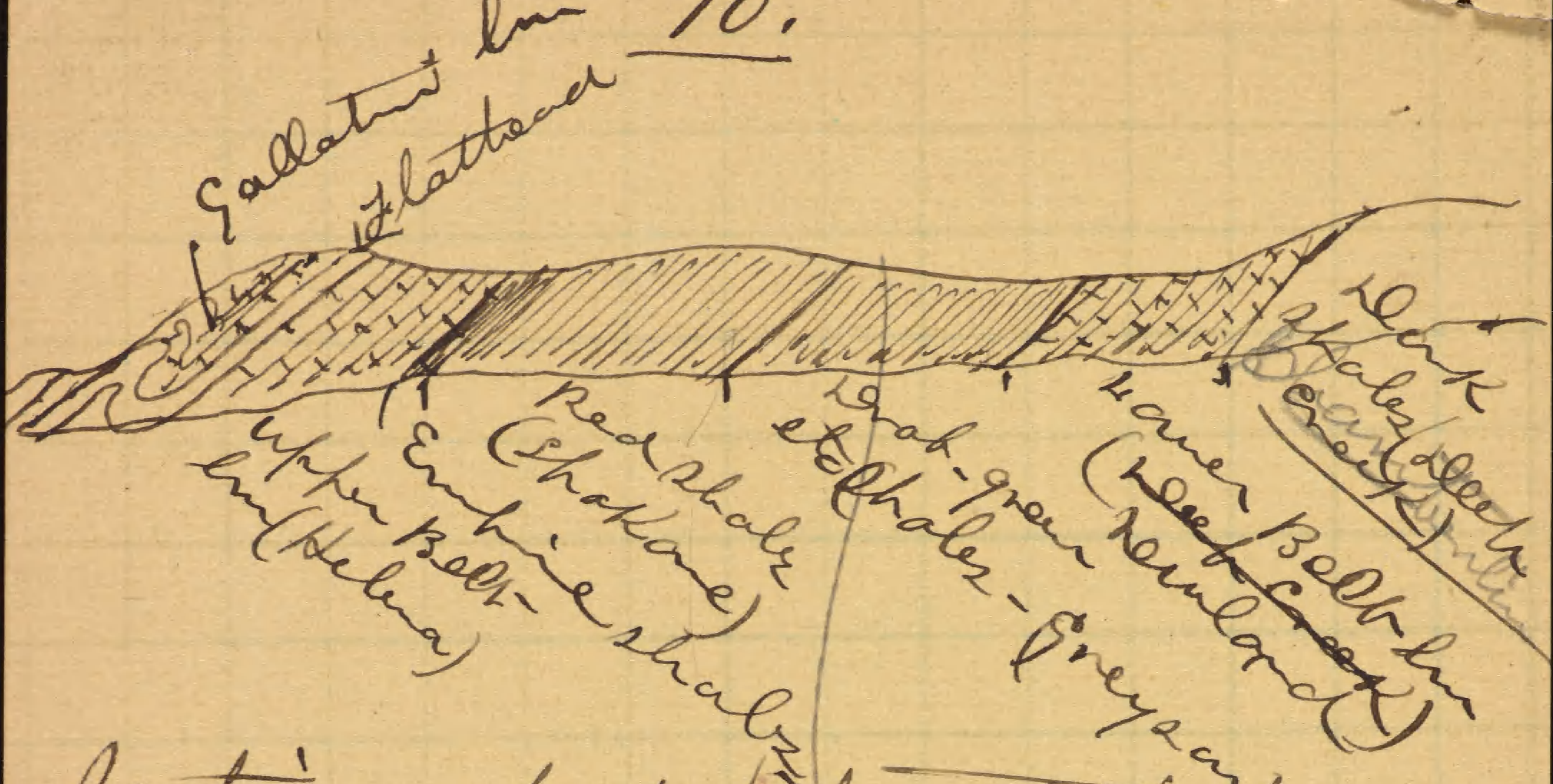
At White Gulch - 12 mi E.S.E. of Canyon Ferry the Flathead rests directly on the upper Belt lm (Helena) as at Helena. It is roughly estimated at 1200 feet in thickness. The red shales (Spokane) are in full force beneath the lm - (Est 1500 feet) and then the greenish - grey - buff - arenaceous, sdy + argillaceous shales - (1200) ~~that~~ carry calcareous bands of shale (Greyson creek)



Section of Whites Gulch -

Below the shales - the lower Belt lm - (Newland) and then the dark siliceous + sdy shales as seen in the distance (~~Deep Creek shales~~).
Chamberlin

The Helena, Spokane Hills + Whites Gulch sections show ~~that the~~ Helena lm - is absent at Spokane Hills - which was probably a line of uplift in Pre-Cambrian time so that ~~and~~ the limestone (Helena) was planed off by the transgressing Cambrian sea – As in the Grand Canyon of the Colorado section –

Here is a wonderful resemblance between the Belt Mt. Mont. Llano (Texas) – Grand Canyon ~~Colorado~~ (Arizona) and Keweenaw (Wis) sections.